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APPENDIX C

HEALTH AND SAFETY PLAN

HEALTH AND SAFETY PLAN
HALBY CHEMICAL SITE
WILMINGTON, NEW CASTLE COUNTY, DELAWARE

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ACRONYMS

ANSI	American National Standard Institute
CaPAHs	Carcinogenic Polynuclear Aromatic Hydrocarbons
CRZ	Contamination Reduction Zone
EZ	Exclusion Zone
HASP	Health and Safety Plan
IDLH	Immediately Dangerous to Life and Health
LEL	Lower Explosive Limit
NRR	Noise Reduction Rating
OSHA	Occupational Safety and Health Administration
PID	Photoionization Detector
PPE	Personal Protective Equipment
SC	Supervising Contractor
SVOCs	Semi-Volatile Organic Compounds
SZ	Support Zone
TLVs	Threshold Limit Values
USEPA	United States Environmental Protection Agency
VOCs	Volatile Organic Compounds

ABBREVIATIONS

mg/m^3	Milligrams per Cubic Meter
ppm	Parts Per Million
μg	Micro Grams

HEALTH AND SAFETY PLAN
HALBY CHEMICAL SITE
WILMINGTON, NEW CASTLE COUNTY, DELAWARE

1.0 INTRODUCTION

1.1 Purpose of this Plan

Langan Engineering and Environmental Services, Inc. (Langan), the Supervising Contractor (SC) has prepared this Health and Safety Plan (HASP) for its employees to address the safety issues that may arise as a result of proposed sampling and investigative activities at the Halby Chemical Site, Wilmington, New Castle County, Delaware. The location of the Halby Chemical Site is shown on Figure 1 and the route to the nearest hospital is shown on Figure 2. The content of the HASP may change or undergo revision based upon additional information, monitoring results or changes in the technical scope of work.

This HASP has been developed in accordance with the Occupational Safety and Health Administration (OSHA) regulation, Title 29, Code of Federal Regulations, Part 1910 (29 CFR 1910.120), "Hazardous Waste Operations and Emergency Response", and Part 1926 (29 CFR 1926 Subpart P), "Excavations". This HASP establishes procedures and provides protocols to minimize potential hazards to SC employees during proposed sampling and investigative activities. Certain discrete site activities such as site surveying and walk-throughs are considered to be non-intrusive in nature. This HASP identifies these activities and establishes procedures and provides protocols to minimize potential hazards. This HASP will be available for review by subcontractors regarding the potential hazards on-site. Subcontractors will follow this plan or generate their own HASP, that is, equivalent to or more stringent than this HASP with regard to personal protective equipment (PPE) and action levels and meets the Project Health and Safety Officer's approval.

1.2 Site Description

The Halby Chemical site, encompassing 14 acres, is located in southeastern Wilmington, New Castle County, Delaware. The triangular property is bordered by Interstate 495 on the northwest, Conrail railroad track on the east, and Terminal Avenue on the southwest.

1.3 Site History

The Halby Chemical site was operated by Halby Chemical Company from 1948 to 1977 as a chemical production facility. The company's three principal products were ammonium thiocyanate, ammonium thioglycolate and isooctyl thioglycolate. A portion of the site was used by the Pyrites Company until 1969 to store pyrite ore for the production of sulfuric acid. In 1972, Halby Chemical Company merged with Argus Chemical Company, a wholly-owned subsidiary of the Witco Corporation. Chemical production activities continued at the site under Witco ownership until the plant closed in 1977. Brandywine Chemical Company, the most recent owner, purchased the property from Witco in 1977.

Brandywine Chemical Company operated the site as a bulk chemical receiving and distribution facility until 1995, when operations were terminated by EPA. During Brandywine's operations, bulk chemicals were shipped to the site via rail or trucks and stored outside in aboveground storage tanks. The chemicals were later repackaged into empty drums and stored either in the warehouse building or outside within the fenced area.

From 1948 to 1964, cooling water, surface water runoff and acid wastewater from the Halby facility were discharged into the drainage ditch located along the northeast border of the process plant area. Liquids from the drainage ditch flowed into an on-site unlined lagoon. The lagoon periodically drained through a tidal marsh southeast of the site into the Lobdell Canal and subsequently into the Christina River. From 1964 to 1972, the acid wastewater was discharged to the county sewer system, and only

cooling water entered the lagoon. By 1975, Witco was periodically diverting the wastewater flow from the county sewer system to a pilot wastewater treatment plant. The treated wastewater was discharged to the lagoon. Production operations at the site ceased in August 1977, after which the site served as a receiving and distribution facility. At some time between May 1977 and June 1983, the northeast bank of the lagoon was breached permitting the lagoon to drain through the drainage ditch along I-495 to the Christina River.

There are two operable units at the Halby Chemical Site. Operable Unit 1 (OU-1) was identified as the soil in the former process plant area. Operable Unit 2 (OU-2) was identified as all groundwater at the site; along with soil, surface water, and sediment which are outside the limits of OU-1.

During the Removal Action performed by the United States Environmental Protection Agency (USEPA) beginning 3 February 1995 and ending 1 August 1995, some of the soil and sediments associated with the Site's drainage system, which includes a sump, discharge pipes, a ditch, and a former lagoon were found to be contaminated with hazardous substances that exhibited Resource Conservation and Recovery Act (RCRA) hazardous characteristics of ignitability, reactivity, and/or corrosivity.

2.0 RESPONSIBILITIES

The proper implementation of this HASP and the prevention of adverse health effects and injuries to site workers depends on the participation of all project members. A definition of the responsibilities of the project team with respect to health and safety issues is provided in the following subsections. Emergency telephone numbers are provided as Table 1.

2.1 Project Health and Safety Officer

The Project Health and Safety Officer is responsible for the technical coordination of the health and safety program, including medical and training requirements, hazard

assessment, air monitoring, personal protective equipment (PPE), and field implementation. The Project Health and Safety Officer will interact directly with the Project Director and provide the Site Safety Officer with details concerning any change in the site characterization and health and safety program requirements.

2.2 Site Safety Officer

The Site Safety Officer is responsible for the implementation of the proper procedures described in this HASP. In the event the Site Safety Officer has to leave the site for any reason, an alternate Site Safety Officer, who is also familiar with the established procedures of this HASP, will be designated. The Site Safety Officer will conduct daily tailgate safety meetings to discuss the hazards associated with tasks to be performed that day and the necessary PPE.

2.3 Field Team Members

The field team members are responsible for implementing the HASP under the supervision of the Site Safety Officer.

2.4 Project Director

The Project Director is ultimately responsible for ensuring that project team members abide by the requirements set forth in this HASP. The Project Director will inform and discuss any changes in the scope of work and HASP requirements with the Project Health and Safety Officer and the Site Safety Officer.

The personnel who are anticipated to be involved in the project activities are as follows:

William F. Mercurio, P.E., Project Director
Robert Y. Koto, P.G., Project Health and Safety Officer
Charles McCusker, P.G. Site Safety Officer

3.0 PLANNED SITE ACTIVITIES

The activities addressed in this HASP include:

- Soils/Sediment Sampling
- Test Pits, Excavations, and Soil Borings
- Surveying and Site Walk Throughs

This HASP address activities which are considered to be field oriented. The health and safety protocols that Langan considers essential for the completion of these activities, based on the available information are included in this HASP.

4.0 HAZARD EVALUATION

Langan has preliminarily evaluated the potential hazards, physical, chemical, biological, and radiological, associated with the planned field activities. Existing information, such as site history and previously conducted sampling, was used in this evaluation. Based on the planned field activities, the following are the potential exposure pathways that will be addressed in this HASP:

- inhalation of airborne vapors and particulates;
- dermal absorption (overall body surface and eye) due to direct skin contact with vapors and contaminated soil; and
- accidental ingestion of contaminated particles.

The following hazards are associated with the planned site activities:

Task	Hazards
Soils/Sediment Sampling	Physical, chemical, biological, and overt personnel exposure
Test Pits, excavations and soil borings	Physical, chemical, biological, and overt personnel exposure

Surveying and Site Walk Throughs	Physical and biological

The types of hazards are described in the following sections.

4.1 Physical Hazards

The physical hazards associated with the field activities include the potential for being struck by falling or flying objects during surveying/sampling operations, slip/trip hazards due to wet and uneven surfaces, heat stress, overhead hazards and noise from heavy machinery, accidental excavation of underground utilities, collapsing of unstable excavations or test pits, and the potential for drowning in the lagoon and drainage ditch should someone fall into the water during sampling activities. Heat stress is caused by a number of factors including the PPE, work load, and environmental conditions. The Langan policy on heat stress prevention is explained in Appendix A. In order to mitigate overhead hazards, hard hats shall be worn at all times while working on site. Ear protection should be worn by any personnel in close proximity to heavy equipment while it is in operation. All areas of excavation and drilling will be cleared for utilities prior to commencement of activities. Field inspection of test pits and areas of excavation will be conducted with extreme caution, personnel will not enter test pits unless they are four feet or less in depth. Banks more than four feet high shall be shored, laid back, or other equivalent means of protection shall be used to prevent cave-ins. Sides of trenches in unstable or soft material four feet or more in depth, shall be shored, braced, sloped, or otherwise supported to protect employees working within them. When employees are required to be in trenches four feet deep or more, an adequate means of egress, such as a ladder or steps shall also be provided so as to require no more than 25 feet of lateral travel. Should personnel be required to use boats for sediment sampling in the lagoon, these personnel will be required to wear life vests as part of their PPE.

4.2 Chemical Hazards

Chemicals of concern are known to occur in the aqueous, gaseous, and solid phase(s). Potential routes of exposure to personnel include inhalation, ingestion, and dermal absorption.

Of particular concern during planned activities is the chemical carbon disulfide. Carbon disulfide is a flammable liquid. Even at low temperatures (e.g. -22°F/-30°C) it gives off flammable vapors, which can form explosive mixtures in confined areas over a wide range of vapor/air mixtures. Products formed by combustion of carbon disulfide include sulfur dioxide and carbon monoxide which are irritating to the respiratory tract and may cause breathing difficulty and pulmonary edema. Symptoms may be delayed several hours or longer depending on the extent of the exposure. Large carbon disulfide fires are best extinguished by completely blanketing the fire area with a water fog or a water spray. Carbon dioxide (or other inert gases) or dry chemical extinguishing agents may be used on small carbon disulfide fires. Table 2 summarizes the remaining chemical hazards of concern.

4.3 Biological Hazards

Due to the location of the work site, along a wooded and vegetated area it is likely that insects will be encountered. Ticks in particular may pose a potential hazard to site workers.

It is suggested that workers check themselves for ticks upon leaving the site or otherwise protect themselves against exposure.

4.4 Radiologic Hazards

Based on the site history and previous environmental investigations, radioactive hazards are not likely to become a problem or hazard.

4.5 Confined Space

Confined spaces are not expected to occur during the pre-design activities. Confined space hazards include deficient oxygen content (less than 19.5%), presence of potentially explosive atmosphere, exceedence of Lower Explosive Limits (LEL) and presence of toxic vapors.

4.6 Overt Personnel Exposure

Generic and specific first aid procedures are included in this section. General first aid procedures include:

Skin Contact: Use copious amounts of soap and water. Wash/rinse affected area at least 15 minutes, then provide appropriate medical attention. Eyewash bottles will be provided on site outside the exclusion zone, as appropriate. Eyes should be rinsed for a minimum of 15 minutes upon chemical contamination.

Inhalation: Move to fresh air and/or, if necessary, decontaminate and transport to hospital.

Ingestion: Decontaminate and transport to emergency medical facility.

Puncture Wound or Laceration: Decontaminate and transport to emergency medical facility. Site Safety Officer will provide medical data sheets to medical personnel as requested.

5.0 AIR QUALITY MONITORING

Air quality monitoring will be conducted during each field activity to ensure that all personnel are adequately protected from potential airborne and chemical hazards. Air monitoring for site surveying and walk throughs will consist of volatile organic vapor monitoring with a Photoionization Detector (PID). The PID will be an HNu model 101 with a 10.2 eV lamp and set at a 9.8 span setting. Air monitoring for field investigations, will consist of airborne

particulate and volatile organic vapor monitoring. Engineering controls such as dust suppression methods (water spray) will be utilized, if determined by the Health and Safety Officer to be necessary, to control airborne particulates.

5.1 Airborne Particulates

Work zone airborne particulate monitoring will be conducted with an MIE Miniram Aerosol Monitor Model PDM-3 or equivalent and Gilian Model HFS 513A personal air sampling pumps or equivalent. A backup Miniram will also be onsite. Work zones will be established during implementation of the RAP.

Personal air samples will be collected during the first full day of operations and weekly thereafter. At a minimum, two personal integrated samples will be collected on a weekly basis. These will be collected from one employee at the highest risk of exposure within the immediate work area and one employee at the highest risk of exposure outside the work area. The sample will be taken during a full shift and analyzed within a 24- to 48-hour period. The analytical parameters are as follows: hexavalent chromium, total chromium, arsenic, and lead. The resultant concentrations will be used by the Project Health and Safety Officer and the Site Safety Officer to determine appropriate levels of personal protection.

Area airborne particulate monitoring will be conducted using a RAM-1 Portable Real-Time Aerosol Monitor with alarm, data logger, and an annular inlet modification device manufactured by MIE, Inc., or equivalent. Each monitor will be placed in the breathing zone, immediately downwind of the activities. Readings of 5 milligrams per cubic meter (mg/m^3) total particulates will be used as the guideline for ceasing operations or institution of engineering controls. A windsock or vane will be used to determine wind directions. If the RAM-1 or Miniram malfunctions, work will stop until the malfunctioning unit is replaced. Backup aerosol monitors will be kept on site or at the project field office.

At a minimum, air monitoring data received from direct readings of aerosol monitors will be taken and recorded on an hourly basis or as directed by the Project Health and Safety Officer.

Perimeter aerosol monitor readings will be recorded continuously. Hourly and complete activity time integrated averages will be recorded. All air monitoring data will be available at the field office. This data will also be submitted with the field sampling report. The frequency of these hourly checks may be increased based on the type of operations being conducted and potential dust generation.

5.2 Volatile Organic Vapors

Based on the existing site history and the maximum level of contaminants found during previous studies, it is anticipated that Level D PPE will adequately protect the workers conducting non-intrusive activities (surveying and site walk throughs) at the Halby Chemical Site. Excavation and sampling activities will commence in Modified Level D protection, provided that PID readings and/or Carbon Disulfide Dräger tube readings stay 1 ppm or below in the breathing zone of personnel. If sustained levels in the breathing zone are above 1 ppm but below 10 ppm, Level C PPE will be utilized. If sustained levels in the breathing zone are greater than 10 ppm, an upgrade to Level B PPE will be instigated. If sustained levels in the breathing zone are greater than 500 ppm, the area will be evacuated.

5.3 Maintenance and Calibration Procedures

The air monitoring equipment to be used on site will consist of Aerosol monitors, Gilian air pumps, dräger tubes, and PIDs. All of these instruments will be calibrated according to the manufacturer's instructions prior to use.

6.0 PERSONAL PROTECTIVE EQUIPMENT

Each task specific level of protection required for the planned field activities is described in the following subsections.

6.1 Level D Protection

Level D protection is defined by the following protection equipment:

- hard hat;
- steel-toed and shanked boots (rubber boots or leather workboots);
- work gloves (when handling site media);
- safety glasses, goggles, or face shield; and
- disposable ear plugs, noise reduction rating (NRR) of 35 decibels or earmuffs (when task involves working around heavy equipment).

6.1.1 Modified Level D Protection

Modified Level D protection requires the addition of the following protection equipment.

- disposable coveralls (woven or chemical-resistant Tyvek suits) taped at the ankles; and
- inner gloves and outer nitrile gloves taped at wrists (when sampling or handling potentially contaminated materials).
- disposable booties or rubber boots.
- life vest for lagoon sampling

6.2 Level C Protection

Level C protection is defined by the following protective equipment:

- chemically resistant (Saran or PVC-coated) Tyvek suites or flame retardant (Nomex™ IIIA) coveralls taped at the ankles;
- inner surgical gloves and outer nitrile gloves taped at the wrists;
- disposable chemical resistant booties;
- hard hat;
- steel-toed and shanked boots;
- full-face respirator with organic vapor, acid gas, and HEPA cartridges (GMC-H Optifilter combination type);
- disposable ear plugs, NRR of 35 decibels or ear muffs (when task involves working around heavy equipment).

6.3 Level B Protection

Level B protection is defined by the following protective equipment:

- flame retardant (Nomex™ IIIA) coveralls;
- inner surgical gloves and outer flame retardant gloves taped at the wrists;
- chemical resistant, flame retardant boots;
- hard hat;
- steel-toed and shanked boots;
- self-contained breathing apparatus (SCBA) or air line; and,
- disposable ear plugs, NRR of 35 decibels or ear muffs (when task involves working around heavy equipment).

The following rules apply to respiratory protection:

- Respiratory protection will be in compliance with OSHA, 29 CFR 1910.134.

- At a minimum, air-purifying cartridges will be replaced daily. Cartridges will also be replaced immediately upon any signs of breakthrough (e.g., odors and physical effects) or at the Site Safety Officer's direction.

- No employee will be assigned to tasks requiring Level B or Level C protection, if based upon the health examination, the physician has determined that the employee will be unable to function normally wearing a respirator or that the safety or health of the employee may be compromised.

7.0 LEVELS OF PROTECTION AND ACTION LEVELS

The level of PPE that will adequately protect a worker is primarily dependent, on the chemicals present, and the route of exposure. The PPE requirements will also vary according to the site activity being performed. However, all personnel will be required to wear safety shoes meeting American National Standard Institute (ANSI) requirements, (i.e. steel toed, steel shanked), and hard hats and safety glasses meeting ANSI requirements, where appropriate. The specific level of PPE that Langan considers necessary for the activities to be performed is dependent upon the established action levels and is summarized in the following subsections. Table 3 summarizes the action levels.

7.1 Soil/Sediment Sampling

These tasks will be performed based on the action levels. The action levels are: 0 to 1 ppm = modified Level D Protection, greater than 1 ppm and less than 10 ppm = Level C Protection, and greater than 10 ppm = Level B Protection. If sustained levels in the breathing zone are greater than 500 ppm, the area will be evacuated.

7.2 Test Pits, Excavations, and Soil Borings

These tasks will be performed based on the action levels. The action levels are: 0 to 1 ppm = modified Level D Protection, greater than 1 ppm and less than 10 ppm = Level C Protection, greater than 10 ppm = Level B Protection. If sustained levels in the area will be evacuated.

7.3 Site Surveying Activities and Site Walk Throughs

Level D protection has been chosen for this activity based on the current knowledge of contaminant levels and the fact that there will be minimal disturbance to the ground surface. However, if the air monitoring results indicate that the action level has been met or exceeded, then the level of PPE will be upgraded according to the action levels.

8.0 SITE CONTROL

The Site Safety Officer is responsible for the designation of work areas and of site access and security.

8.1 Designation of Work Areas

The Site Safety Officer will designate the exclusion zone, the contamination reduction zone, and the support zone for each activity.

8.1.1 Exclusion Zone

An Exclusion Zone (EZ) will be established in the immediate vicinity of the work area. This zone has higher potential for worker exposure to hazards and, therefore, movement into and out of this zone will be controlled. The outer boundary of this zone (the hotline) will be determined and roped off whenever feasible. Personnel entering or working in this zone will wear the required level of PPE and the rule of the buddy system will always be followed.

The criteria for designation of the EZ will be based on the necessary area needed to complete the work. The exclusion zone will be designated such that only the portions of the site where work is being performed will be monitored.

8.1.2 Contamination Reduction Zone

The Contamination Reduction Zone (CRZ) will be delineated by the Site Safety Officer. Decontamination of the PPE, personnel, tools, and equipment, along with the proper disposal of the PPE will be performed in this zone.

8.1.3 Support Zone

A Support Zone (SZ) will be established directly outside the CRZ. This area will be used to store sampling equipment and other equipment that is needed for immediate use. The support zone is accessible to supervisors for observation of the work area and to site visitors.

8.2 Site Access and Security

Since this site is located in an industrial neighborhood, site access and security will have to be monitored. All visitors to a specific work area should be reported to the Site Safety Officer and all unauthorized people should be kept at a safe distance from the designated work areas. All visitors must sign the Site Visitors Log included in the HASP (Appendix B).

Toilet facilities and potable water will available at the site.

9.0 DECONTAMINATION

The Site Safety Officer will designate the location for decontamination if being performed according to the activity being performed. Decontamination of equipment (mixing bowls and spatulas) will be performed by the analytical laboratory.

Decontamination procedures for Level D and modified Level D protection depend on which personal protective clothing has been worn during the tasks. The decontamination procedures for Level C are as follows.

- Equipment and samples will be placed in a designated area.
- Before leaving work area, knock off all heavy soils from gloves and boots.
- Proceed to decontamination station. Step into boot wash station, wash gloves and boots, wipe off respirator and hood, if needed.
- After boot wash station, remove outer gloves and throw gloves into hazardous waste cans.
- Remove outer boots and hang on boot rack (respirator still on).
- Proceed to remove outer suit and throw into hazardous waste can.
- Remove latex inner gloves and throw into waste cans.
- Once clear of decontamination station, remove respirator and throw cartridges into hazardous waste can.
- Clean respirator and hang up to dry.
- If taking a break, wash hands and face.
- At the end of the day, take a full shower and wash hair.

Decontamination for Level B protection will follow the same procedures outlined above, except that assistance with removal of the SCBA will be provided at the equipment drop.

10.0 GENERAL WORK PRACTICES

The following work practices will be employed on-site.

- Contact lenses will not be worn in the EZ or the CRZ. All field personnel requiring corrective lenses must provide their own prescription glasses and/or lenses, which may be fitted into the respirator masks.

- No beards, sideburns, or mustaches that interfere with respirator mask seals will be permitted.

- No jewelry that interferes with protective clothing or respirator seals will be worn.

- Activities such as walking through puddles or mud, kneeling on ground, etc., will be avoided, whenever possible, to prevent contact with potentially contaminated substances.

- Field work will be conducted only during daylight hours unless adequate lighting is provided.

- Long hair and loose or dangling clothing articles that may interfere with the worker's ability to perform the tasks will not be permitted.

- The buddy system, where personnel maintain contact, will be observed at all times while in the EZ.

- Health and safety related aspects of the field activities will be documented. The documentation will also include any instances of potential chemical exposure.

- Before digging or drilling, the existence and the location of any underground utilities, (pipelines or electric lines) must be determined. The appropriate utility company(ies) will be contacted. Prior to the start of digging, a Utilities and Structures Checklist must be completed (Appendix C).

- A copy of this HASP will be kept on-site at all times for reference.

- The Site Safety Officer will inform all subcontractors of the potential hazards associated with tasks to be performed. A copy of this HASP will be made available for their review.

- A tailgate safety meeting will be conducted daily to discuss the associated hazards of tasks to be performed and the necessary PPE. This meeting will be the responsibility of the Site Safety Officer who will keep records using the Tailgate Safety Meeting Form (Appendix D).

11.0 STANDING ORDERS

11.1 Standing Orders for Exclusion Zone

- No smoking, eating, or drinking.
- No horse play.
- No matches or lighters.
- Check-in on entrance.
- Check-out on exit.
- Implement the communications system.
- Line of sight must be in position when appropriate.
- Wear the appropriate level of protection as defined in the HASP.

11.2 Standing Orders for Contamination Reduction Zone

- No smoking, eating, or drinking.

- No horse play.
- No matches or lighters.
- Wear the appropriate level of protection.

12.0 EMERGENCY RESPONSE PLAN

Langan has determined that the protocols described below are necessary during emergencies. The Site Safety Officer will inform all field personnel of emergency and evacuation procedures. The route to the hospital is provided on Figure 2. Local emergency numbers are included in Table 1.

12.1 Buddy System

The buddy system is required for all site work involving levels of protection or conditions which represent a risk to personnel.

12.2 On-Site Communications

On-site verbal communications are not expected to be a problem. However, if the level of protection is upgraded to C, the following set of hand signals should be used to communicate:

- hand gripping throat - cannot breathe;
- gripping partner's wrist or placing both hands around waist - leave work area immediately, no debates;
- hands on top of head - need assistance;
- thumbs down - no (negative); and
- thumbs up - yes (affirmative).

12.3 Job-Related Illnesses and Injuries

All job-related illnesses and injuries will be reported immediately to the Site Safety Officer. If medical attention is needed when the worker is in the EZ, the worker will be decontaminated, if possible, prior to leaving the EZ. The Site Safety Officer will complete an Accident Report Form (Appendix E). This completed form must be forwarded to the Project Health and Safety Officer.

Local enforcement authorities (police, fire department, hospital) will be contacted and notified in advance of the planned pre-design sampling. A copy of the HASP will be provided to the fire department and hospital.

12.4 Route to Hospital

The hospital address is as follows:

St. Francis Hospital
7th and Clayton Streets
Wilmington, Delaware
(302) 421-4100

The hospital can be reached from the site via:

Terminal Thoroughfare west to Castle Road (State Route 9) North.

Castle Road to 4th Street

West on 4th Street to Washington Street

North on Washington Street to 7th Street

West on 7th Street to Clayton Street

The route to the hospital is provided on Figure 2.

12.5 Spill Containment Program

As a result of the potential hazards at the site, and the conditions under which operations are conducted, it is possible that an emergency situation such as a spill may develop.

If a spill occurs, the workers, will secure their own safety first and then will try to control or stop the spread of contamination. The Site Safety Officer will instruct a person on site to immediately contact local authorities to inform them of the possible or immediate need for neighborhood evacuation. If a significant release has occurred, the National Response Center should then be contacted at 1-800-424-8802. This group will alert National or Regional Response Teams, as necessary. Following these emergency calls, the reporting individual should then notify the Langan Health and Safety Officer and EPA site manager.

13.0 ACCIDENT PREVENTION AND CONTINGENCY PLAN

13.1 Accident Prevention

Constant monitoring of the field activities by the Site Safety Officer will be performed to ensure compliance with the safety plan. The appropriate emergency telephone numbers (fire, police, hospital, ambulance, etc.) will be posted next to the telephone in the project field office at all times.

Fire prevention is also a concern due to the possible flammable nature of the chemicals of concern. Langan field vehicles all carry fire extinguishers and a fire extinguisher will be located at the field office trailer. A first-aid station will also be located at the office for handling minor cuts, burns, abrasions, and eye irritations. Fire extinguishers, first-aid kits, and spill kits will be close at hand during the sampling, and investigative activities. The specific locations of all fire extinguishers and safety equipment will be reviewed with all on-site personnel at the beginning of the field activities.

All field personnel will receive health and safety training and briefing prior to the initiation of any site activities. On a day-to-day basis, individual personnel should be constantly alert for indicators of potentially hazardous situations, and for signs and symptoms in themselves and others that warn of hazardous conditions and exposures. Rapid recognition of dangerous situations can avert an emergency. Before daily work assignments, regular meetings will be held. Discussion will include:

1. Tasks to be performed.

2. Time constraints.

3. Hazards that may be encountered, including their effects and how to recognize symptoms or other danger signals.

4. Emergency procedures.

13.2 Contingency Plan

General emergency procedures and specific procedures for chemical exposure and personal injury are described in the following sections.

13.3 Emergency Procedures

In the event that an emergency develops on-site, the procedures delineated herein are to be immediately followed. Emergency conditions are considered to exist if:

1. Any field personnel is involved in an accident or experiences any adverse effects or symptoms of exposure while on-site.

2. A condition is discovered that suggests the existence of a situation more hazardous than anticipated.

13.4 Chemical Exposure

The chemical exposure potential from the materials present at this site are considered to be low. If field personnel demonstrate symptoms of a known or unanticipated chemical exposure, the procedures outlined below should be followed:

1. Another team member (buddy) should remove the individual from the immediate area of contamination. The field team leader should contact the appropriate emergency response agency.

2. Precautions should be taken to avoid exposure of other individuals to the hazard.

3. If the chemical is on the individual's clothing, the chemical should be neutralized or removed if it is safe to do so.

4. If the chemical has contacted the skin, the skin should be washed with copious amounts of water.

5. In case of eye contact, an emergency eyewash should be used. Eyes should be washed for at least 20 minutes. (The recommended flushing time for eye contact with alkali materials is 20 minutes.)

6. All chemical exposure incidents must be reported in writing to the Project Health and Safety Officer. The Site Safety Officer or field team leader is responsible for completing the accident report.

13.5 Evacuation Procedures

In case an evacuation is deemed necessary, the following procedures should be followed:

1. The field team leader will initiate the evacuation procedure with a readily visible or audible signal to all on-site personnel.

2. All personnel in the work area should evacuate the area and meet in the common designated area.

3. All personnel suspected to be in or near the contract work area should be accounted for and the whereabouts of missing persons determined immediately.

4. Further instructions will then be given by the field team leader.

13.6 Procedures Implemented in the Event of a Major Fire, Explosion, or On-site Health Emergency Crisis

Although the anticipated hazards associated with this work scope are low, the following procedures should be followed in the event of an on-site crisis:

1. Notify the paramedics and/or fire department, as necessary.

2. Signal the evacuation procedure previously outlined and implement the entire procedure.

3. Isolate the area.

4. Stay upwind of any fire.

5. Keep area surrounding the problem source clear after the incident occurs.

6. Complete accident report form and distribute to appropriate personnel.

In the event of a fire or explosion, the local fire department will be summoned immediately. Upon their arrival, the Site Safety Officer will advise the fire commander of the location, nature, and identification of the hazardous materials onsite.

If it is safe to do so, site personnel may:

- Use fire fighting equipment available onsite to control or extinguish the fire; and

- Remove or isolate flammable or other hazardous materials which may contribute to the fire.

14.0 MEDICAL SURVEILLANCE AND TRAINING

All contractor personnel must be covered by corporate medical surveillance and training programs that comply with the OSHA 29 CFR 1910.120 and pertinent contractor policy. All subcontractors are responsible for the training and medical surveillance of their own personnel.

Completion of the 40-Hour Hazardous Waste Training Program is required for all personnel who will perform work in areas where the potential for a toxic exposure exists.

Advanced training is necessary for any personnel expected to perform specialized operations on site.

Training will be provided that will specifically address the activities, procedures, monitoring, and equipment for the site operations. It will include site and facility layout, hazards, and emergency services at the site, and will detail all provisions contained within this HASP. Specific issues that will be addressed include the hazards described in Section 4. This training will also allow field workers to clarify anything they do not understand and to reinforce their responsibilities regarding safety and operations for their particular activity.

TABLES

ORIGINAL (Red)

TABLE 1

EMERGENCY TELEPHONE NUMBERS, HALBY CHEMICAL SITE, WILMINGTON, NEW CASTLE COUNTY, DELAWARE

AGENCY	PHONE NUMBER
For all emergencies in the Wilmington area	911
Wilmington Fire Department	(302) 571-4414
Wilmington Police Department	(302) 571-4512
St. Francis Hospital	(302) 421-4100
USEPA Mr. Eric Newman	(215) 597-0910
DNREC Ms. Jane Biggs-Sanger	(302) 323-4540
Witco Corporation Mr. Raj Vyas	(203) 552-2476
Langan Engineering and Environmental Services, Inc. Mr. William Mercurio	(201) 794-6900
National Response Center	1 (800) 424-8802

TABLE 2
CHEMICAL HAZARDS OF CONCERN

Contaminant	PEL/TLV/IDLH	Source Concentration Onsite	Route of Exposure	Symptoms of Acute Exposure	Monitoring Device
Coal Tar Pitch Volatiles	Ca PEL=0.1 mg/m³ IDLH=80 mg/m³	(Soil) up to 500 mg/kg for each compound	Inh Con	Derm, bron, [carc]	None
Antimony	PEL=0.5 mg/m³ IDLH=50 mg/m³	(Soil) 3,810 mg/kg maximum concentration	Inh Con	Irrit nose, throat, mouth; cough, dizz; head; nau, vomit, diarr; stomach cramps; insom; anor; irrit skin; unable to smell properly; cardiac abnormalities in antimony trichloride exposures	RAM, mini RAM
Arsenic	Ca PEL=0.002 mg/m³ IDLH=5 mg/m³	(Soil) 4,470 mg/kg maximum concentration	Inh Abs Con Ing	Ulceration of nasal septum, derm, GI disturbances, peri neur, resp irrit, hyperpig of skin, [carc]	RAM, mini RAM
eryllium	Ca PEL=0.0005 mg/m³ IDLH=4 mg/m³	(Soil) 7.1 mg/kg maximum concentration	Inh	Resp symptoms, weak, ftg, weight loss, [carc]	RAM, mini. RAM
Manganese	PEL=1 mg/m³ STEL=3 mg/m³ IDLH=500 mg/m³	(Soil) 26,100 mg/kg maximum concentration	Inh, Ing	Parkinson's; asthenia; insom, mental conf; mental flume fever; dry throat, cough, tight chest, dysp, rales, flu-like fever; low back pain; vomit; mal; ftg	RAM, mini RAM
Mercury	PEL=0.05 mg/m³ IDLH=10 mg/m³	(Soil) 96 mg/kg maximum concentration	Inh Abs Con	Cough, chest pain, dysp, bron pneuitis; tremor, insom; irrity, indecision; head, ftg, weak; stomatitus, salv; GI dist, anor, low-wgt; prot; irrit eyes, skin	Gold Film Mercury Vapor Analyzer
Nickel	Ca PEL=0.015 mg/m³ IDLH=10 mg/m³	(Soil) 252 mg/kg maximum concentration	Inh Ing Con	Head, verti; nau, vomit, epigastric pain; substernal pain; cough, hypernea; cyan; weak; leucyt, pneuitis; delirium, convuls; [carc]	RAM, mini RAM

_A - substance that NIOSH considers to be a potential carcinogen

TABLE 2--continued
CHEMICAL HAZARDS OF CONCERN

Contaminant	PEL/TLV/IDLH	Source Concentration Onsite	Route of Exposure	Symptoms of Acute Exposure	Monitoring Device
Vanadium	PEL=0.05 mg/m³ IDLH=35 mg/m³	(Soil) 627 mg/kg maximum concentration	Inh Ing Con	Irrit eyes; green tongue, metallic taste, eczema; cough; fine rales, wheez, bron, dysp; irrit throat	RAM, mini RAM
Ammonia	PEL=25 ppm STEL=35 ppm IDLH=300 ppm	(Soil) Process/ Concentration Unknown	Inh Ing Con	Eye, nose, throat irrit; dysp, bronspas, chest pain; pulm edema; pink frothy sputum; skin burns, vesic	Dräger Tube
Hydrogen Sulfide	PEL=10 ppm IDLH=100 ppm	(Soil) Process/ Concentration Unknown	Inh Con	Irrit eyes, nose, throat; nau, vomit, diarr; metallic taste, garlic breath; dizz, lass, ftg; in animals; pneuitis, liver damage	Dräger Tube
Sulfuric Acid	PEL=1 mg/m³ IDLH=0.5 mg/m³	(Soil) Process/ Concentration Unknown	Inh Ing Con	Eye, nose, throat irrit; pulm edema, bron; emphy; conj; stomatis; dental erosion; trachbronch; skin, eye burns; derm	RAM, mini RAM
Cyanide	PEL=4.7 mg/m³ IDLH=50 mg/m³	(Soil) 40 mg/kg maximum concentration	Inh Abs Ing Con	Asphy and death can occur; weak, head, conf; nau, vomit; incr rate resp; slow gasping resp; irrit eyes; skin	Dräger Tube, RAM, mini RAM
Carbon Disulfide	Ca PEL=1 ppm STEL=10 ppm IDLH=500 ppm	(Soil) 110,000 mg/kg maximum concentration	Inh Abs Ing Con	Dizz, head, poor sleep, ftg, ner, anor, low wght, psychosis, polyneur; Parkinson-like syndrome, ocular changes, coronary heart disease, gastritis, kidney, liver damage, eye, skin burns; derm	Dräger Tube HNu

TABLE 2--continued
CHEMICAL HAZARDS OF CONCERN

Abbreviations for symptoms of exposure and target organs

Abbreviation	Symptom/organ	Abbreviation	Symptom/organ
anor	Anorexia	irrity	Irritability
asphy	Asphyxia	lass	Lassitude (weakness, exhaustion)
bron	Bronchitis		
bronspas	Bronchospasm	leucyt	Leukocytosis (increased blood leukocytes)
[carc]	Potential occupational carcinogen	low-wgt	Weight loss
conf	Confusion	nau	Nausea
conj	Conjunctivitis	ner	Nervousness
convuls	Convulsions	peri neur	Peripheral neuropathy
cyan	Cyanosis	pneuitis	Pneumonitis
derm	Dermatitis	polyneur	Polyneuropathy
diarr	Diarrhea	prot	Proteinuria
dizz	Dizziness	pulm	Pulmonary
dysp	Dyspnea (breathing difficulty)	resp	Respiratory
emphy	Emphysema	salv	Salivation
ftg	Fatigue	trachbronc	Tracheobronchitis
GI	Gastrointestinal	verti	Vertigo (an illusion of movement)
head	Headache		
hyperpig	Hyperpigmentation	vesic	Vesiculation
incr	Increase(d)	vomit	Vomiting
insom	Insomnia	weak	Weakness
irrit	Irritation	wheez	Wheezing

TABLE 3

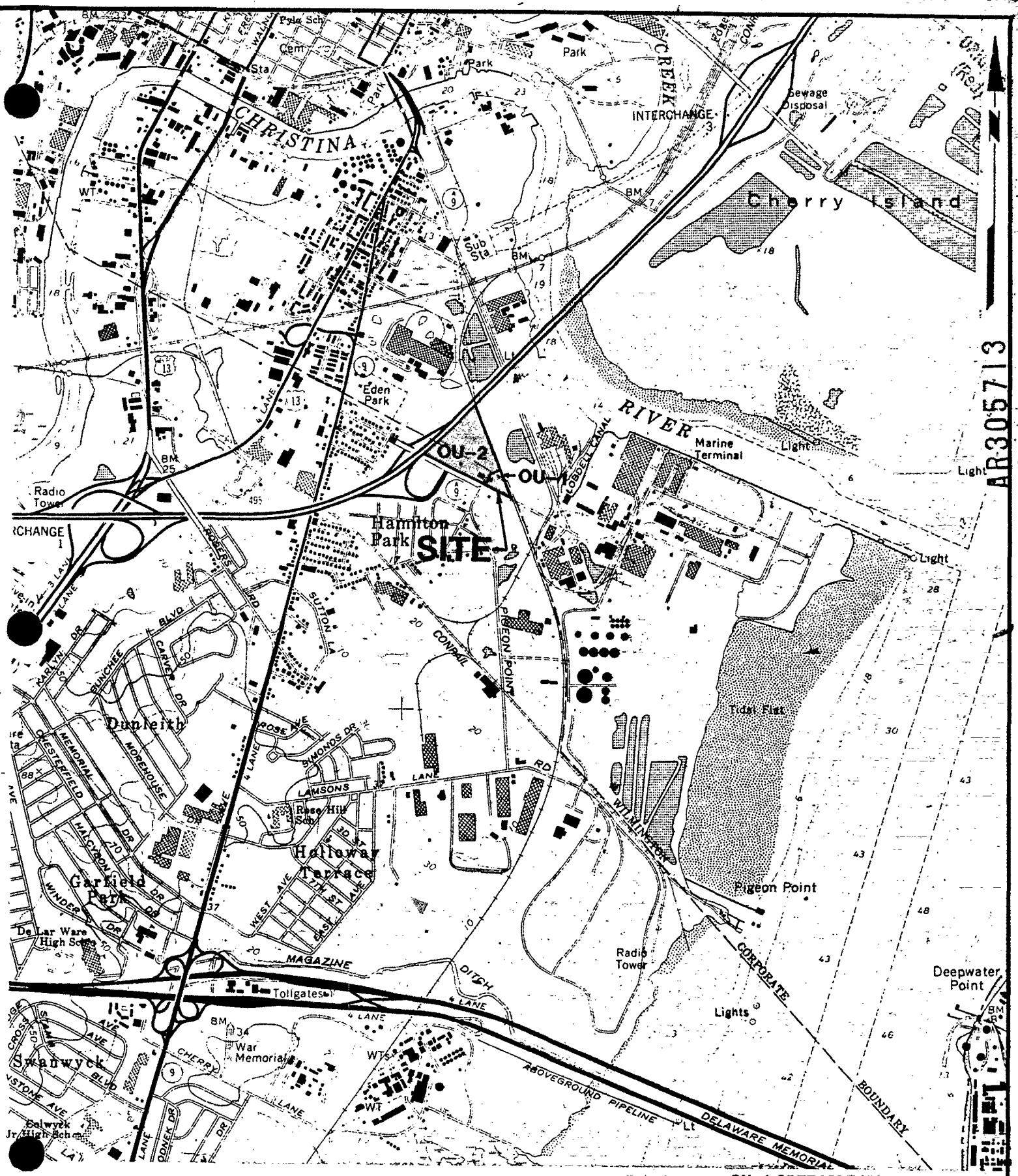
ACTION LEVELS

Instrument	Action Level	Level of PPE
PID*	Background (Bkgd)	Level D or Modified Level D
and/or		
Carbon Disulfide	Bkgd to 1 ppm	Level D or Modified Level D
Dräger tube	1 ppm to 10 ppm	Level C
	10 ppm to 500 ppm	Level B
	Greater than 500 ppm	Evacuate

* Photoionization Detector calibrated to benzene or its equivalent. Measurement made in the breathing zone of personnel.

FIGURES

ORIGINAL
(Red)



U.S.: WILMINGTON SOUTH, DEL.–N.J. U.S.G.S. QUADRANGLE MAP, 1987

OU-1 OPERABLE UNIT 1
OU-2 OPERABLE UNIT 2

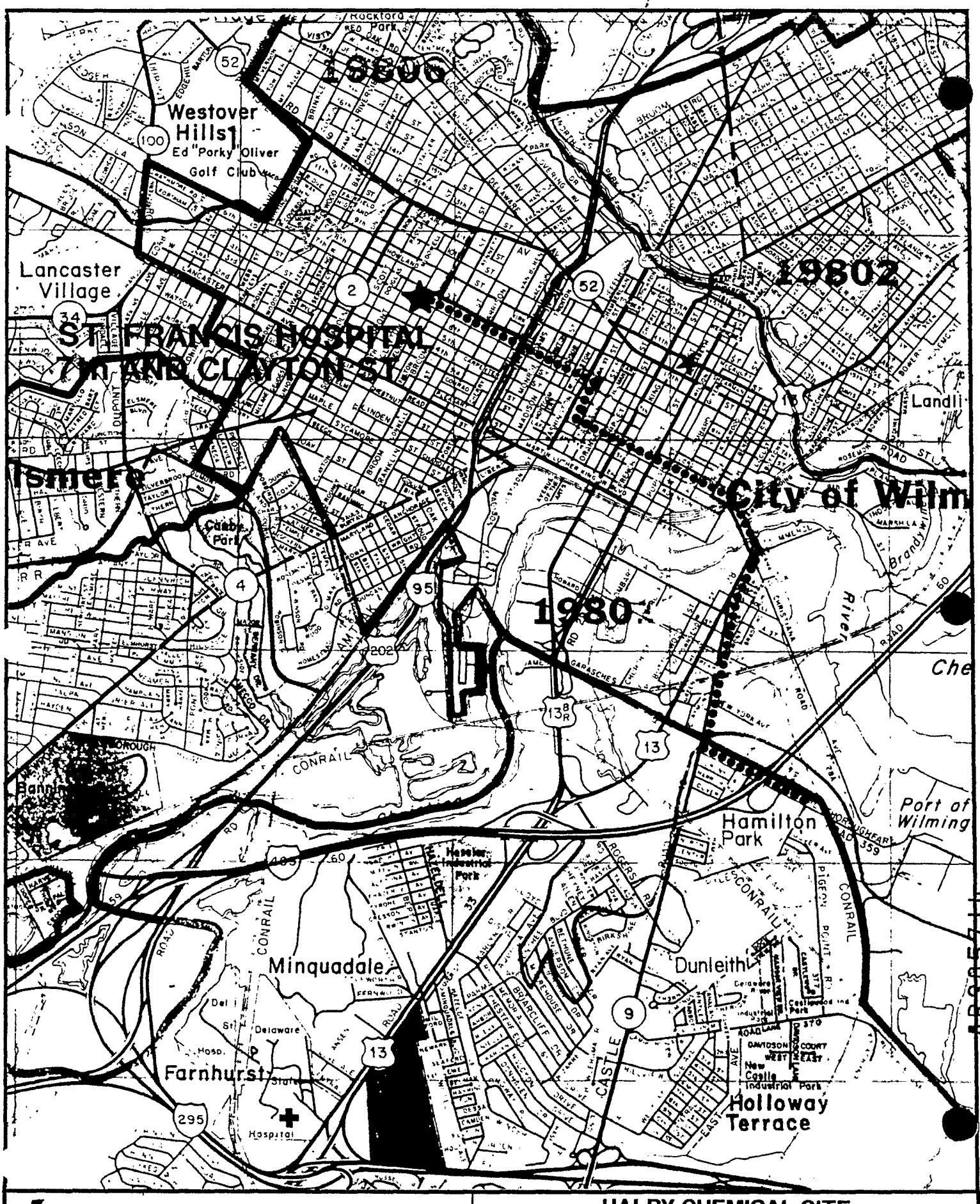
Langan
Engineering and Environmental Services, Inc.

ELMWOOD PARK NJ • NEW YORK NY • MIAMI FL • WEST PALM BEACH FL • DOYLESTOWN PA

HALBY CHEMICAL SITE
SITE LOCATION MAP

WILMINGTON DELAWARE

PROJ	SCALE	DATE	FIG NO
2061601	1"=2000'	8/1/95	1



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HALBY CHEMICAL SITE
ROUTE TO HOSPITAL

WILMINGTON DELAWARE

PROJ	SCALE	DATE	FIG NO
2061601	1"=1000'	8/8/95	2

APPENDIX A

HEAT STRESS GUIDELINES

APPENDIX A
HEAT STRESS GUIDELINES

OVERVIEW

Heat stress is caused by a number of interacting factors, including environmental conditions, personal protective equipment, work load, and the individual characteristics of the worker. This section provides guidance in recognizing the symptoms of heat stress and in implementing preventive measures to minimize worker's exposure.

REGULATORY GUIDANCE

Currently there are no federal regulations pertaining specifically to heat stress. However, guidance is provided by many individual groups and agencies and includes the American Conference of Governmental Industrial Hygienists (ACGIH), National Institute of Occupational Safety and Health (NIOSH), Occupational Safety and Health Administration (OSHA), U.S. Coast Guard (USCG), and U.S. Environmental Protection Agency (USEPA).

PERTINENT ISSUES

Each individual has different susceptibilities to heat stress due to many factors. These factors include age, physical fitness, degree of acclimatization, and the specific task being performed. Symptoms of heat stress are divided into five general categories as follows:

1. Behavioral Disorders: A worker suffering from heat fatigue demonstrates symptoms such as the inability to concentrate, impaired performance, and loss of coordination.

2. Skin Eruptions: Profuse tiny raised red vesicles (blister-like) on affected areas, prickling sensation during heat exposure, prickly heat. Extensive areas of the skin that do not sweat upon heat exposure, but present a goose-flesh appearance that subside with cool environments.

3. Heat Exhaustion: This is a condition which results from extensive water and/or salt depletion. Symptoms include fatigue, nausea, headaches, giddiness, clammy skin,

pale complexion, and fainting. Heat cramps are also a symptom of heat exhaustion. These painful spasms of muscles (arms, legs, or abdominal) can occur during or after work hours.

4. Heat Syncope: Symptoms associated with this stage of heat stress include the individual fainting while standing erect and the individual becoming immobile.

5. Heat Stroke: Symptoms usually associated with heat stroke are hot dry skin, usually red, mottled, or blue. Additional symptoms include confusion, loss of consciousness, and convulsions.

To minimize employees' exposures to heat stress, it is important for field personnel to recognize the early signs and symptoms of heat stress so that preventive measures can be taken. Preventive measures include work schedule adjustment, rotating personnel, and selection of personal protective equipment.

1. Adjustment of Work Schedules: In environments of extreme heat and humidity, work schedules should be modified. Heavy work should be conducted during the cooler hours of early morning or early evening when the ambient temperature is usually lower. During the hotter temperatures, usually associated with mid-day, light work tasks should be performed whenever possible. Subcontractors should be informed of the potential for adjusted work schedules.

2. Rotation of Personnel: By alternating job functions, a single worker may not be overstressed or overexerted as a result of performing heavy tasks throughout the day.

3. Increase in Rest Periods: In extreme environmental conditions, the number of rest periods should be increased. Shaded areas or air conditioned facilities (trailer, cars, buildings) should also be provided for these rest periods so that workers can adequately recover.

Bodily fluids should also be maintained at normal levels. A good guide to follow is for every ounce lost in sweat, the fluid intake should equal that amount. Water is recommended as the fluid of choice (no salt should be administered). Field showers or hose-down areas should be provided to reduce body temperature.

In choosing protective clothing, the insulating properties should be as low as possible while still providing the protection against chemical hazards. Water chill vests and ice vests are also available and can be used effectively to minimize the effects of heat stress.

APPENDIX B

SITE VISITORS LOG

APPENDIX B

SITE VISITORS LOG

VISITOR REVIEW OF SITE HEALTH AND SAFETY PLAN			
THE UNDERSIGNED VISITORS REQUIRE ENTRANCE TO THE EXCLUSION ZONE AND HAVE THOROUGHLY READ THE HEALTH AND SAFETY PLAN, UNDERSTAND THE POTENTIAL HAZARDS AT THE SITE AND THE PROCEDURES TO MINIMIZE EXPOSURE TO THE HAZARDS, WILL FOLLOW THE DIRECTION OF THE SITE HEALTH AND SAFETY OFFICER, AND WILL ABIDE BY THE HEALTH AND SAFETY PLAN.			
NAME (PRINT)	COMPANY	DATE	SIGNATURE

APPENDIX C

UTILITIES AND STRUCTURES CHECKLIST

UTILITIES AND STRUCTURES CHECKLIST

Project: _____ Prepared by: _____
Location: _____ Date: _____

Instructions. This checklist has to be completed by a staff member as a safety measure to insure that all underground utility lines, other underground structures as well as above-ground power lines are clearly marked out in the area designated for boring or excavation. DRILLING OR EXCAVATION WORK MAY NOT PROCEED UNTIL LINES ARE MARKED AND THIS CHECKLIST HAS BEEN COMPLETED. Arrangements for underground utility markouts should be made at the time of the preliminary site visit to allow client and/or utility company sufficient time. Keep completed checklist and send copy to Project Manager.

Assignment of Responsibility. Client is responsible for having underground utilities and structures located and preferably, the utilities themselves should mark out the lines.

Drilling or Excavation Sites. Attach a map of the property showing the proposed drilling or excavation site clearly indicating the area(s) checked for underground utilities or underground structures and the location of above-ground power lines.

Utilities and Structures

Type	Not Presented	Presented	How determined(1)
Petroleum products line			
Natural gas line			
Steam line			
Water line			
Sewer line			
Storm drain			
Telephone cable			
Electric power line			
Product tank			
Septic tank/drain field			
Overhead power line			

1) Flags, paint on pavement, wooden stakes, etc.

Name and affiliation of person who marked out underground liens or structures.

Name	Organization	Phone

Emergency Procedures
Persons at site or facility to contact in case of emergency
1. _____ Phone _____
2. _____ Phone _____
Fire Dept:Phone _____ Ambulance::Phone _____
Utility:Phone _____ Utility:Phone _____
Utility:Phone _____ Utility:Phone _____
Directions to nearest hospital (describe or attach map).

APPENDIX D

TAILGATE SAFETY MEETING FORM

TAILGATE SAFETY MEETING

Client _____ Prepared by _____
Date _____ Project _____
Work Location _____ Project Number _____
Type of Work to be Done _____

SAFETY TOPICS PRESENTED

Chemical Hazards _____

Physical Hazards/Underground Utilities _____

Protective Clothing/Equipment _____

Special Equipment _____
Emergency Procedures _____

Hospital/Clinic _____ Phone ( ) _____
Paramedic Phone ( ) _____
Hospital Address _____
Other _____

ATTENDEES

NAME PRINTED	SIGNATURE

Meeting Conducted by _____ _____
Name Printed Signature

Note: This tailgate safety form must be completed daily.

APPENDIX E

ACCIDENT REPORT FORM

EMPLOYEE EXPOSURE/INJURY INCIDENT REPORT
(Submit a Separate Report for Each Incident)

Date: _____

Employee's Name: _____ Employee No: _____

Sex: M _____ F _____ Age: _____

Region: _____ Location: _____

Project: _____ Project No: _____

Incident: _____

Type: Possible Exposure _____ Exposure _____ Physical Injury _____

Location: _____

Date of Incident: _____ Time of Incident: _____

Date of Reporting Incident: _____

Person to Whom Incident was Reported: _____

Weather Conditions During Incident: Temperature _____ Humidity _____

Wind Speed and Direction: _____ Cloud Cover: _____

Clear: _____ Precipitation: _____

Materials Potentially Encountered: _____

Chemical (give name of description - liquid, solid, gas, vapor, fume, mist):

_____

_____

Radiological: _____

Other: _____

Nature of the Exposure/Injury: (State the nature of the exposure/injury in detail and list the parts of the body affected. Attach extra sheets if necessary).

_____

_____

_____

_____

_____

_____

Did you receive medical care? Yes _____ No _____ If so, when _____

Where? On Site _____ Off Site _____

By Whom: Name of Paramedic: _____

Name of Physician: _____

Other: _____

If "Off Site," name facility (hospital, clinic, etc.):

_____

Length of stay at the facility? _____

Was the Regional Health and Safety Manager contacted? Yes ___ No ___ When? ___

Was the ICF HSO or Contract Occupational Health Physician contacted?

Yes ___ No ___

If so, who was the contact? _____

Did the exposure/injury result in permanent disability? Yes _____ No _____

If so, explain: _____

_____

_____

_____

Has the employee returned to work? Yes _____ No _____

If so, give date: _____

List the names of other persons affected during this incident:

_____

_____

_____

_____

_____

_____

List the names of persons who witnessed the exposure/injury incident?

_____

_____

_____

_____

_____

_____

Possible Cause of the Exposure/Injury Incident?

What was the name and title of the field team leader or immediate supervisor at the site of the incident? _____

Was the operation being conducted under an established Safety Plan?

Yes _____ No _____ If yes, attach a copy. If no, explain

Describe protective equipment and clothing used by the employee:

Did any limitations in safety equipment or protective clothing contribute to or affect exposure? If so, explain:

What was the employee doing when the exposure/injury occurred? (Describe briefly as "Site Reconnaissance," "Site Categorization," "Sampling," etc.)

Where exactly on site or off site did the exposure/injury occur?

How did the exposure/injury occur? (Describe fully what factors led up to and/or contributed to the incident):

Name of person(s) initiating report, job title, phone number:

Employee Signature

Date

Site Health and Safety Coordinator Signature

Date

ORIGINAL
(Red)

ATTACHMENT A

AR305730

DRAFT

HEALTH AND SAFETY PROGRAM

FOR

HAZARDOUS WASTE OPERATIONS

SECTION VI

PERSONAL PROTECTION GUIDELINE #1
RESPIRATORY PROTECTION PROGRAM

Revisions	Date

Langan
Engineering and Environmental Services, Inc.

SECTION VI
PERSONAL PROTECTION GUIDELINE #1
RESPIRATORY PROTECTION PROGRAM

TABLE OF CONTENTS

6.0 PURPOSE

This Respiratory Protection Program has been established to ensure that respirators are properly selected, fitted, used and maintained as necessary to protect the health of employees. This Program has been developed pursuant to the requirement of 29 CFR 1910.134. (Sites covered by 29 CFR 1910.120 shall have a site specific HASP that identifies the type of respiratory protection to be utilized.)

6.1 Scope

This guideline applies to Langan Engineering and Environmental Services, Inc. (Langan) work situations where respirators may be used.

6.2 Definitions

Adequate Warning Properties - The detectable characteristics of a hazardous chemical including odor, taste, and/or irritation effects which are detectable and persistent at concentrations at or below the hazardous exposure level, and exposure at these low levels does not cause olfactory fatigue.

Air Purifying Respirator - A respirator which is designed to remove air contaminants (i.e. dust, fumes, mists, gases, vapors, or aerosols) from the ambient air.

Atmosphere Supplying Respirator - A respirator which supplies air or oxygen from a source independent of the immediate ambient atmosphere. This includes supplied-air respirators and self-contained breathing apparatus (SCBA) units.

Buddy System - A system of organizing employees into work groups in such a manner that each employee of the work group is designated to observe the activities of and remain in communication with at least one other employee in the work group.

Immediately Dangerous to Life or Health (IDLH) - An atmospheric concentration of any toxic, corrosive or asphyxiating substance that poses an immediate threat to life or would cause irreversible or delayed adverse health effects or would interfere with an individual's ability to escape from a dangerous atmosphere.

Maximum Use Concentration (MUC) - The maximum concentration of an air contaminant in which a particular respirator can be used, based on the respirator's assigned protection factor. The MUC cannot exceed the use limitations specified on

the NIOSH/MSHA approval label for the cartridge, canister, or filter. The MUC can be determined by multiplying the assigned protection factor for the respirator by the permissible exposure limit for the air contaminant for which the respirator will be used.

Negative Pressure Respirator - A respirator in which the air pressure inside the facepiece is positive during exhalation in relation to the outside air pressure and negative during inhalation in relation to the outside air pressure.

Oxygen Deficient Atmosphere - A atmosphere with an oxygen content of less than 19.5% by volume.

Positive Pressure Respirator - An atmosphere supplying respirator which is designed so that air pressure inside the facepiece is positive in relation to the outside air pressure during inhalation and exhalation.

Powered Air Purifying Respirator - An air purifying respirator which uses a blower to deliver air through the air purifying element to the wearer's breathing zone.

Pressure Demand - A mode of operation for atmosphere supplying respirators in which the air pressure inside the respirator is maintained at a specific positive pressure differential with respect to the ambient air pressure. To maintain this pressure differential additional air is admitted to the facepiece when the wearer inhales.

Protection Factor - The value OSHA regards as applicable for an achievable ratio of average ambient concentration of an air contaminant in a workplace to the average concentration of the contaminant measured inside the respirator facepiece for a specific class of respirators.

Qualitative Fit Test - An assessment of the adequacy of respirator fit by determining whether or not an individual wearing the respirator can detect the odor, taste, or irritation of a contaminant introduced into the vicinity of the wearer's head.

Quantitative Fit Test - An assessment of the adequacy of respirator fit by numerically measuring concentrations of a challenge agent inside and outside the facepiece. The ratio of the measurements is an index between the respirator facepiece and the wearer's face.

Respirator - Any device worn by an individual and intended to provide the wearer with respiratory protection against inhalation of airborne contaminants or oxygen-deficient air.

Approved Respirator - A respirator which has been tested, found to meet established performance criteria, and listed as being approved by an authority such as MSHA

(Mine Safety and Health Administration) or NIOSH (National Institute of Occupational Safety and Health).

Self Contained Breathing Apparatus (SCBA) - An atmosphere supplying respirator for which the source of air or oxygen is carried by the wearer.

Supplied Air Respirator - A respirator which receives breathing air through an air line or hose from a portable or stationary source of compressed air.

6.3 Responsibilities

Respirator Program Administrator - The Respiratory Program Administrator (RPA) is responsible for the implementation of the requirements outlined in this guideline. The RPA is also responsible for the continual examination and modification of the existing program to meet changing conditions. The RPA shall be a person trained in respiratory protection.

Health and Safety Manager (HSM) - The HSM shall insure that the respiratory protection practices prescribed by this guideline are followed.

Health and Safety Coordinator (HSC) - The HSC shall ensure that the proper respirator for the specific job is available, that employees have been adequately trained and medically qualified for respirator use, that facilities are provided for the cleaning and storage of respirators, and that operating procedures reflect the required use of respirators.

Employees - Employees must use the provided respiratory protection in accordance with instructions and training received. The employee must check the facepiece seal each time the respirator is worn. The employee must routinely inspect the respirator as instructed, protect it from damage, and report malfunctions.

6.4 Guidelines

6.4.1 Respirator Selection

Respirator selection should be performed by a knowledgeable person and be based upon the limitations of the various types of respirators. Attachment A and Figure 1 should be used to assist in selection of respirators. Respiratory protection requirements will be outlined in the HASP.

6.4.2 Respirator Training

Employees required to wear respirators must be trained before wearing a respirator at a work site and at least annually thereafter. This training may occur as part of other health and safety training, for example, forty- (40) hour health and safety training for hazardous waste operations or site specific training. The following, as a minimum shall be included:

1. Instruction in nature, extent, and effects of the respiratory hazard, whether acute, chronic, or both;

2. Discussion of why a certain respirator is the proper selection for a particular purpose;

3. Explanation of the operation, capabilities and limitations of the selected respirator;

4. Instruction in the procedures for inspection, donning and removal, checking the fit and seals, and wearing of the respirator which shall include sufficient practice to enable the employee to become thoroughly familiar and confident in the use of the respirator;

5. Procedures for the cleaning, maintenance and storage of the respirator;

6. Instructions in recognizing and coping with emergencies, including periodic emergency drills;

7. The location and availability of the Respiratory Protection Program; and

8. An explanation of the wearer's responsibilities under the Respiratory Protection Program.

6.4.2.1 Training Record

A copy of the training record shall be maintained in the employee's personnel file.

6.4.3 Respirator Fitting

Each employee required to wear a respirator shall be individually fitted using the methods prescribed by this guideline prior to initial use of the respirator, whenever a different make or size respirator is used, and at least annually thereafter. Employees shall be given the opportunity to select a properly fitted respirator from an assortment of sizes of facepieces and different manufacturers to insure a good fit.

6.4.4 Respirator Usage

6.4.4.1 Facial Hair

Facial hair lying between the sealing surface of a respirator facepiece and the wearer's skin will prevent a good seal; therefore, anyone who has facial hair may not wear a respirator. Even a few days growth will permit excessive contaminant penetration.

6.4.4.2 Glasses/Goggles/Prescription Eyewear

Spectacles or goggles should be worn so they do not interfere with the seal of the facepiece of half-mask respirators.

6.4.4.3 Dentures/Orthodontia

Dentures or missing teeth may cause respirator facepiece sealing problems. Full dentures should be worn when wearing a respirator to obtain the proper seal between face and facepiece.

6.4.4.4 Cold Weather

Full-facepiece respirators shall be equipped with a nose-cup to deflect the exhaled breath away from the facepiece, and inhalation and exhalation valves to prevent fogging of the lens and freezing of the valves. Anti-fogging compounds, available from several manufacturers, can also prevent fogging when applied to the inner surface of the lens and may be used where appropriate. Respirators shall be inspected frequently in cold weather to insure proper operation of the inhalation and exhalation valves.

6.4.5 Respirator Maintenance and Care

Respirators shall be serviced regularly in order to keep them properly maintained and in good working order.

6.4.5.1 Inspection/ Repair

Respirators shall be regularly inspected for defects and to insure that all functioning parts are intact. Respirators which are defective or have missing parts shall be tagged as such and removed from use until repaired and reinspected.

Respirators must be serviced only by personnel who have been adequately trained. Also, the substitution of parts from a different brand or type of respirator invalidates approval of the device.

6.4.5.2 Frequency of Inspections

All respirators used in non-emergency situations shall be inspected before and after each use. All respirators maintained for emergency situations, including escape and rescue devices shall be inspected at least once monthly, as well as after each use.

6.4.5.3 Inspection Procedures

Respirator inspections shall include checking the:

1. Tightness of the connections;

2. Condition of:
   a. Facepiece;
   b. Head straps;
   c. Valves;
   d. Connecting tubes; and
   e. Canisters, filters, or cartridges;

3. Pliability and condition of rubber or elastomer parts; and

4. Regulator and warning devices, as well as, air or oxygen cylinders on SCBA equipment (cylinders shall be charged according to manufacturer's instructions);

A record of inspection for emergency-use respirators must be maintained that identifies the date of inspection, name of the person who made the inspection and means of identifying the inspected respirator.

6.4.5.4 Cleaning and Disinfecting

All washable parts should be washed in cleaner-sanitizer solution, rinsed thoroughly in hot water and then dried at room temperature in a non-contaminated atmosphere, after each use.

6.4.5.5 Storage

1. Respirators shall be stored to protect against:

   a. Dust;
   b. Sunlight;
   c. Heat and extreme cold;
   d. Excessive moisture;
   e. Damaging chemicals; and
   f. Mechanical damage.

2. Respirators shall not be stored on a workbench, in a tool cabinet or toolbox among heavy tools, greases, and dirt.

3. Any respirator kept for non-routine or emergency use shall be demarcated or clearly marked, readily accessible, and all employees must be made aware of its location.

4. SCBA equipment shall be located in an area that will remain uncontaminated.

5. Compressed-air cylinders for SCBA units should be stored in individual compartmentalized storage racks. The air cylinder valves should be covered with plastic bags or dust caps to prevent contamination of the valve outlet.

6. Non-emergency respirators shall be stored in plastic bags or otherwise protected from contamination or damage.

6.4.5.6 Cartridge Changes

Chemical cartridges and canisters should be replaced, as necessary, to provide complete protection.

Particulate - removing filters become more efficient (but harder to breathe through) as they fill up. Filters must be replaced as necessary to avoid high resistance to breathing.

Respirator cartridges should be removed and disposed of at the end of each work day.

6.4.6 Medical Surveillance

No employee shall be assigned to a task that requires the use of a respirator unless it has been determined that the employee is physically able to perform under such conditions. A review of the employee's condition should be made periodically as outlined in the Medical Surveillance Program.

6.4.7 Recordkeeping

In order to properly maintain the Respiratory Protection Program, records of employee respirator assignment, medical surveillance, and program surveillance should be kept.

6.4.8 Emergency Use

Written procedures for the use of respirators in emergency situations are required. If necessary, these procedures will be found in the site specific HASP. These procedures shall include the provisions which follow.

1. Employees shall be required to wear positive-pressure, SCBA or combination full-facepiece, pressure-demand, supplied-air respirator with auxiliary self-contained air supply (escape devices) in unknown and/or potentially IDLH environments and environments where the oxygen content is below 19.5%.

2. The "buddy system" shall be implemented when respirators are to be used in IDLH, unknown, or potential IDLH atmospheres.

3. Employees entering IDLH atmospheres must have available retrieval equipment for lifting or removing of employees from the hazardous area.

4. Emergency assistance personnel present shall be equipped with a positive-pressure SCBA.

5. Procedures that shall insure proper air quality, quantity, and flow for atmosphere-supplying respirators shall be implemented.

6.4.9 Program Evaluation

The Respiratory Protection Program must be evaluated. These written evaluations shall be conducted on an annual basis, as a minimum. (See Attachment C.) The Respiratory Program evaluations should:

1. Consult with users to determine program acceptance and other factors such as, fatigue brought on by respirator use and the interference of respiratory protection with job performance;

2. Conduct inspections of respirator use, to insure proper implementation of the program and to determine if respirators are being properly selected and correctly used;

3. Review the procedures for use of respiratory protection in emergencies and modify these procedures as necessary; and

4. Review the records of usage, storage, inspections, and medical surveillance to determine the effectiveness of the program.

6.5 References

1. "NIOSH" Guide to Industrial Respiratory Protection" Pub. 87-116, HEW (Health, Education and Welfare), NIOSH

2. OSHA (Occupational Safety and Health Administration) Respiratory Protection Standard for General Industry 29 CFR Part 1910.134

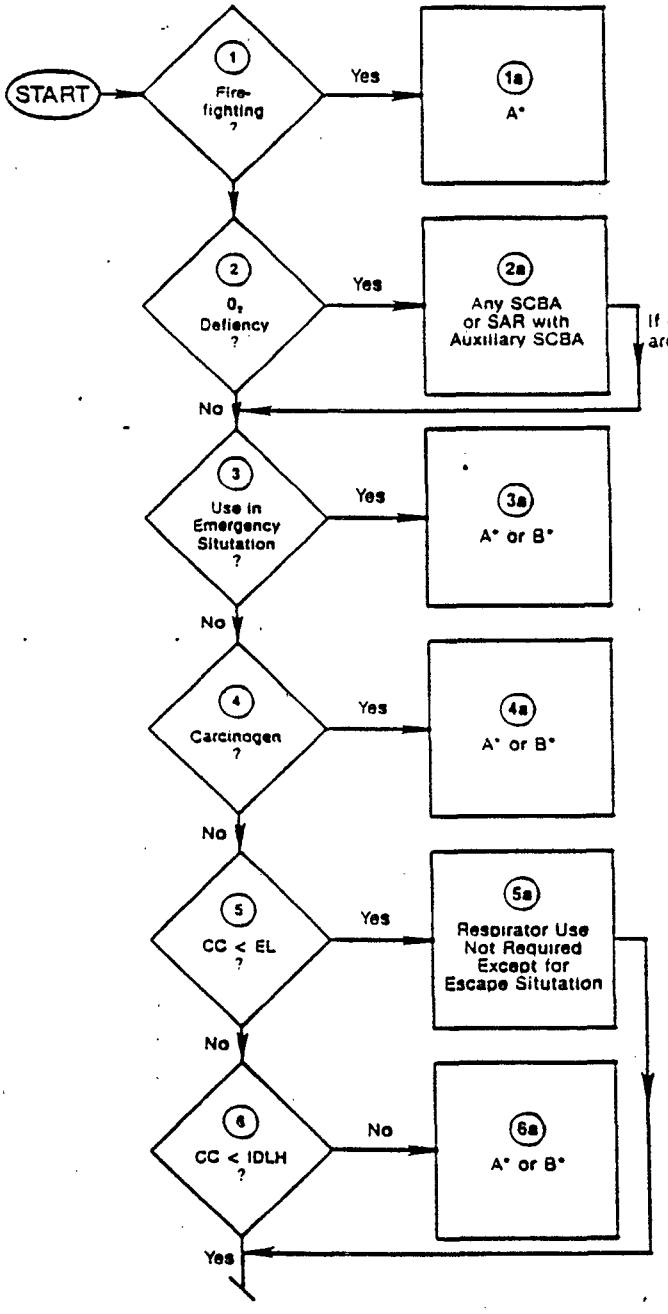
3. American National Standards Institute Z 88.2, American National Standard Practice for Respiratory Protection

4. Manufacturer's Literature

6.5 ATTACHMENTS

Figure 1
A - Respirator Selection
B - Facepiece Seal Tests
C - Respirator Program Evaluation Checklist

The Respirator Decision Logic Sequence is presented in Figure 1 in the form of a flow chart. This flow chart can be used to identify suitable classes of respirators for adequate protection against specific environmental conditions. Refer to the corresponding narrative section for additional information pertaining to a specific part of the flow chart.



KEY: CC—Contaminant Concentration
EL—Exposure Limit
ESLI—End of Service Life Indicator
FF—Full Facepiece
IDLH—Immediately Dangerous to Life or Health
PD—Pressure Demand
PF—Protection Factor
PFa—Assigned PF
PFmin—Minimum PF
PP—Positive Pressure
SCBA—Self-Contained Breathing Apparatus
SAR—Supplied-Air Respirator

A* - SCBA with FF operated in PD or PP mode.

B* - Type C supplied-air respirator (airline) operated in PD or PP mode with auxiliary SCBA.

C* - Escape respirator or gas mask with appropriate filter/sorbent (Subparagraph 5); if O_2 deficient, then SCBA.

Figure 1. — Flow Chart of Respirator Decision Logic Sequence

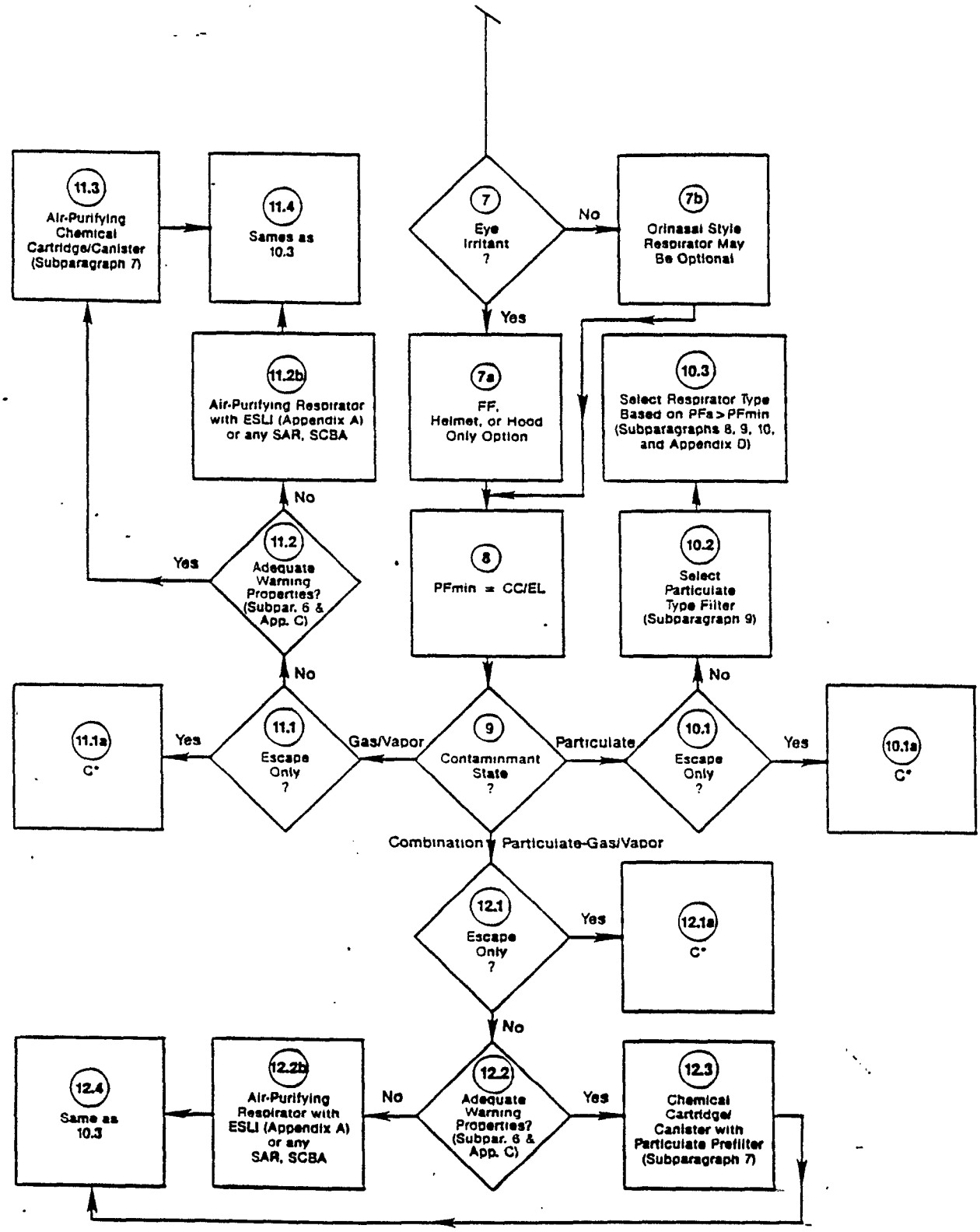


Figure 1. — Flow Chart of Respirator Decision Logic Sequence — Continued

ATTACHMENT A
RESPIRATOR SELECTION

The following factors shall be considered in the selection of a respirator for a given situation.

1. Nature of the hazard.

    a. Type of hazard - oxygen deficiency or air contaminant
    b. Physical and chemical properties of the air contaminant
    c. Physiological effects on the body
    d. Actual concentration of air contaminant
    e. Established Permissible Exposure Limit or Threshold Limit Value of the air contaminant
    f. Whether the hazard is immediately dangerous to life or health
    g. Warning properties

2. Characteristics of the hazardous operation or process.

3. Location of the hazardous area with respect to a safe area having respirable air.

4. The time period that respiratory protection will be worn by employees during the work shift.

5. The work activities of the employees and the potential stress of these work conditions on employees wearing the respirators.

6. The physical characteristics, functional capabilities, and limitation of the respirator.

7. The respirator protection factors and respirator fit.

TYPES OF RESPIRATORS

AIR-PURIFYING RESPIRATORS

Air-purifying respirators purify ambient air, either mechanically or chemically, as inhaled air passes through a filter or cartridge which removes particles, vapors, gases, or a combination the three. Air-purifying respirators have restrictions which are outlined below.

1. Air-purifying respirators remove contaminants from ambient air but do not supply oxygen; therefore, air-purifying respirators cannot be used in oxygen-deficient atmospheres.

2. Air-purifying respirators cannot be used in IDLH atmospheres.

3. Air-purifying respirators cannot be used for a hazardous chemical with poor or inadequate warning properties unless:

    a. Their use is permitted under the provisions of a substance-specific OSHA standard; or

    b. The odor or irritation threshold is not in excess of three times the hazardous exposure level; there is no associated ceiling limit and available information indicates that an undetected exposure between one and three times the hazardous exposure level would not cause or significantly contribute to serious or irreversible health effects; and

    c. One of the following conditions has been met:

        1. The respirator has an end-of-service life indicator approved by NIOSH/MSHA for use with the specific chemical; and

        2. A change schedule has been implemented to assure that air-purifying cartridges and/or filters are replaced before 80% of their useful service life has expired, based upon documented service life data, airborne concentration of the chemical, and duration of exposure.

4. All filters and cartridges used shall be labeled and color coded with the NIOSH/MSHA approval label.

Air-purifying respirators have limitations based upon the maximum use concentrations. The maximum use concentration for air-purifying respirators is determined by the design efficiency and capacity of the filter or cartridge and the facepiece-to-face-seal on the user.

There are three basic types of air-purifying respirators: the mechanical filter; chemical cartridge; and powered air-purifying respirators.

ATMOSPHERE-SUPPLYING RESPIRATORS

These respirators provide air from a source independent of the surrounding atmosphere. Types of atmosphere-supplying respirators include the (SCBA) Self-Contained Breathing Apparatus and the Airline respirator.

AIRLINE RESPIRATORS

The Airline respirator consists of a half-mask, full-facepiece, hood or helmet to which respirable air (independent of ambient air) is supplied from a stationary source through a hose. Three types of air supply may be used.

a. Continuous flow which maintains air flow at all times to the mask (this maintains positive pressure under the mask).

b. Demand air flow which supplies the mask only when the wearer inhales.

c. Pressure-demand flow which maintains a positive pressure in the facepiece.

Airline respirators have limitations which are outlined below.

a. Pressure-demand airline respirators equipped with an auxiliary self-contained air supply (for escape) carried and activated by the wearer (should the airline supply fail) may be used in IDLH atmospheres, unknown environments, or where the measured oxygen content is less than 19.5%. All other types of airline respirators may not be used in unknown or IDLH environments.

b. Airline respirators can be used to provide respiratory protection in oxygen-deficient atmospheres where the measured oxygen-content is between 16.0 and 19.5%.

SELF-CONTAINED BREATHING APPARATUS

SCBAs can provide respiratory protection in oxygen-deficient environments and in situations where large or unknown concentrations of toxic gases, vapors, or particulate are present. When using SCBAs, the wearer's air supply is independent of the conditions of the ambient atmosphere. All SCBAs employ a full facepiece connected to a source of air or oxygen carried by the wearer. Closed-circuit (rebreathing) devices also contain a carbon dioxide-absorbing material. SCBAs are divided into three basic types.

1. Demand or pressure-demand, open-circuit systems supplied by compressed air or oxygen stored in a cylinder.

2. Self-generating, closed circuit devices.

3. Liquid or compressed oxygen or air, closed-circuit, demand or pressure-demand (rebreathing) devices.

CLASS D BREATHING AIR

The compressed air supplied to atmosphere supplying respirators must meet the requirements of the Compressed Gas Association Specification G7.1 (ANSI Z86.1973) for Type 1, Class D gaseous air. This requires that carbon monoxide levels not exceed 20 ppm, carbon dioxide not exceed 1000 ppm, and condensed hydrocarbons not exceed 5 mg/m^3.

ATTACHMENT B
FACEPIECE SEAL TESTS

The Negative-Pressure and Positive-Pressure Sealing Tests are to be used whenever the respirator is donned or adjusted to insure a proper facepiece-to-face seal of the respirator. Facepiece seal tests do not provide the employee with the required opportunity to wear the respirator in a test atmosphere; Qualitative and Quantitative fit tests must be used for this purpose.

NEGATIVE-PRESSURE SEALING TEST

The wearer can perform this test unassisted whenever a respirator is donned. The test consists of the following:

1. Closing off the inlets of the canister, cartridge(s), or filter(s) by either covering with the palm(s), placing a seal over the canister or cartridge inlets, or by squeezing the breathing tubes to restrict the flow of air;

2. Inhaling gently so the facepiece collapses slightly; and

3. Holding breath for ten seconds.

If the facepiece remains slightly collapsed and no inward leakage is detected, the respirator fit is considered satisfactory. This can only be used on respirators with tightly-fitting facepieces.

POSITIVE-PRESSURE SEALING TEST

This test is very much like the Negative-Pressure Sealing Test in that it can be performed unassisted each time the respirator is donned. The Positive-Pressure Sealing Test consists of:

1. Closing off the exhalation valve; and

2. Exhaling gently into the facepiece.

The fit is considered satisfactory if a slight positive pressure can be built up inside the facepiece without any evidence of outward leakage. For some respirators, this method requires that the wearer remove the exhalation valve cover and then carefully replace it after the test (often a difficult task). Removing and replacing the exhalation valve cover often disturbs the respirator fit; therefore, this test should be used sparingly if it requires removing and replacing the valve cover. The Negative Pressure Test should be used in its place. This test is most effective for respirators whose valve covers have a single small port that can be covered by the palm of the hand or finger.

ATTACHMENT C
RESPIRATORY PROGRAM EVALUATION

1. The HSM will conduct frequent inspections of respirator use to determine the correct respirators are being used and worn properly.

2. Wearers will be consulted periodically about their acceptance of respirators. This will include evaluating any discomfort, resistance to breathing, fatigue, interference with vision and communication, restriction of movement, or interference with job performance that may be occurring.

3. The results of periodic usage and storage inspections, consultation with wearers, workplace surveillance, and medical surveillance reports will be reviewed and analyzed to determine the effectiveness of the program.

4. The HSM will review the program annually and the Respiratory Protection Program shall be modified as necessary.

ATTACHMENT C
RESPIRATOR PROGRAM EVALUATION CHECKLIST

In general, the respirator program should be evaluated for each job or at least annually, with program adjustments, as appropriate, incorporated to reflect the evaluation results. Program function can be separated into program administration and operation.

A. PROGRAM ADMINISTRATION

____ (1) Is there a written Respiratory Protection Program which acknowledges employer responsibility for providing a safe and healthful workplace and assigns program responsibility, accountability, and authority?

____ (2) Is program responsibility vested in one individual who is knowledgeable and who can coordinate all aspects of the program?

____ (3) Can feasible engineering controls or work practices eliminate the need for respirators?

____ (4) Does the written Respiratory Protection Program cover the various aspects of the respirator program, including:

____ Designation of an administrator;
____ Respirator selection;
____ Purchase of MSHA/NIOSH certified equipment;
____ Medical aspects of respirator usage:
____ Issuance of equipment;
____ Fitting;
____ Training;
____ Maintenance, storage, and repair;
____ Inspection;
____ Use under special conditions; and
____ Work area surveillance?

B. PROGRAM OPERATION

Respiratory protective equipment selection

____ Are work area conditions and worker exposures properly surveyed?

____ Are respirators selected on the basis of hazards to which the worker is exposed?

____ Are selections made by individuals knowledgeable of proper selection procedures?

____ Are only certified respirators purchased and used; do they provide adequate protection for the specific hazard and concentration of the contaminant?

____ Has a medical evaluation of the prospective user been made to determine physical and psychological ability to wear the selected respiratory protective equipment?

____ Where practical, have respirators been issued to the users for their exclusive use, and are there records covering issuance?

Respiratory protective equipment fitting

____ Are the users given the opportunity to try on several respirators to determine whether the respirator they will subsequently be wearing is the best fitting one?

____ Is the testing conducted on a yearly basis?

____ Are those users who require corrective lenses properly fitted?

____ Is the facepiece-to-face seal tested in a test atmosphere?

____ Are workers prohibited from wearing respirators in contaminated work areas when they have facial hair or other characteristics that may cause face seal leakage?

Respirator use in the work area

____ Are respirators being worn correctly (i.e., head covering over respirator straps)?

____ Are workers keeping respirators on all the time while in the work area?

Maintenance of respiratory protective equipment

Cleaning and Disinfecting

____ Are respirators cleaned and disinfected after each use when different people use the same device, or at the end of each day's use for respirators issued to individual users?

____ Are proper methods of cleaning and disinfecting utilized?

Storage

____ Are respirators stored in a manner so as to protect them from dust, sunlight, heat, excessive cold or moisture, or damaging chemicals?

____ Are respirators stored properly in a storage facility to prevent them from deforming?

____ Is storage in lockers and tool boxes permitted only if the respirator is in a carrying case or carton?

Inspection

____ Are respirators inspected before and after each use and during cleaning?

____ Are individuals/users instructed in inspection techniques?

____ Is respiratory protective equipment designated as "emergency use" inspected at least monthly (in addition to after each use)?

____ Are SCBA breathing gas containers inspected weekly for breathing gas pressure?

____ Is a record kept of the inspection of "emergency use" respiratory protective equipment?

Repair

____ Are replacement parts used in repair those of the manufacturer of the respirator?

____ Are repairs made by manufacturers or manufacturer-trained individuals?

Special Use Conditions

____ Is a procedure developed for respiratory protective equipment usage in IDLH atmospheres?

____ Is a procedure developed for equipment usage for entry into confined spaces?

Training

____ Is training conducted annually?

____ Are users trained in proper respirator use, cleaning, and inspection?

____ Are users trained in the selection of respirators?

____ Are users evaluated before and after training?

Reviewed/Updated: _____ Date: _____
Signature

ATTACHMENT B

DRAFT

HEALTH AND SAFETY PROGRAM

FOR

HAZARDOUS WASTE OPERATIONS

SECTION VII

PERSONAL PROTECTION GUIDELINE #2
PERSONAL PROTECTION EQUIPMENT (PPE)

Revisions	Date

Langan
Engineering and Environmental Services, Inc.

SECTION VII
PERSONAL PROTECTION GUIDELINE #2
PERSONAL PROTECTIVE EQUIPMENT (PPE)

TABLE OF CONTENTS

7.0 PURPOSE

Employees shall wear personal protective equipment (PPE) when there is a reasonable probability of injury that can be prevented by such equipment. The use of PPE can itself create significant worker hazards, such as heat stress, physical and psychological stress, impaired vision, mobility, and communication. For these reasons, and the fact that OSHA has established regulations governing the use of PPE, equipment and clothing that provide an adequate level of protection yet avoids over-protection should be selected.

This guideline establishes procedures for proper selection and use of PPE for use at Langan Engineering and Environmental Services, Inc. (Langan) work sites.

7.1 Scope

This guideline applies to all PPE selection decisions to be made in implementation of Langan.

7.2 Definitions

Degradation - The loss of or change in a fabric's chemical resistance or physical properties due to use, exposure to chemicals, or ambient conditions (e.g., sunlight).

Penetration - The movement of chemicals through zippers, stitched seams or imperfections (e.g., pinholes) in protective clothing material.

Permeation - The process by which a chemical dissolves in and/or moves through protective clothing material, on a molecular level.

7.3 Responsibilities

Health and Safety Coordinator (HSC) - The HSC will use these guidelines to develop each site specific Health and Safety Plan (HASP), conduct a workplace hazard assessment as appropriate, and select personal protective equipment for job tasks.

Employee - Employees are responsible for wearing the appropriate PPE as designated.

7.4 Guidelines

7.4.1 Hazard Assessment

The HSC must assess the worksite to determine if hazards are present, or likely to be present, which necessitate the use of PPE.

This assessment is to be documented. See Attachment A.

7.4.2 Types of PPE

The following types of PPE form the basis of the protective clothing scheme.

1. Head Protection. Regulated by 29 CFR 1910.135; specified in ANSI Z89.1, Safety Requirements for Industrial Head Protection (1986). Head protection equipment include hard hats, hard hat liners, hoods, and protective hair coverings.

2. Eye and Face Protection. Regulated by 29 CFR 1910.133(b); specified in ANSI Z87.1, Eye and Face Protection (1989). Eye and face protection equipment include face shields, safety glasses, and goggles.

3. Ear Protection. Regulated by 29 CFR 1910.95; specified in 41 CFR Part 50-204.10 and OSHA regulation. Ear protection equipment include ear plugs and ear muffs.

4. Foot Protection. Regulated by 29 CFR 1910.136; specified in ANSI Z41.1, Safety Toe Footwear (1991). Foot protection equipment include safety boots and overboots.

5. Hand Protection. Not specifically regulated. Hand and arm protection equipment include inner disposable gloves, overgloves and sleeves.

6. Protective Clothing. Not specifically regulated. Protective clothing equipment include fully encapsulating suits, non-encapsulating suits, aprons, leggings, and sleeve protectors.

7.4.2.1 Foot Protection

Foot protection shall be required when there is a reasonable probability of injury that can be prevented by such equipment, such as when working with heavy equipment, piping, etc.

1. Shoes shall be Class 75 for men, equivalent to Class 50 for women, and shall meet the specifications of American National Standard for Safety Toe Footwear, ANSI Z41 1991. The class, which defines the minimum requirements for compression and impact shall be stamped by the manufacturer on the shoe interior.

2. Specially constructed shoes may be required for specific work environments. For example:

   a. Reinforced soles, inner soles of flexible metal, or steel shanks are to be used for construction work and other work with the potential for protruding hazards.

3. Overboots may be required for chemical protection.

7.4.2.2 Eye and Face Protection

The eye and/or face protection (safety glasses, goggles, faceshields) shall be required where there is a reasonable probability of injury that can be prevented by such equipment.

Eye protection equipment referred to includes protection against impact, penetration, molten metal splashes, chemical splashes, dusts, glare, and injurious light radiation (infrared and ultraviolet) It does not include the special protection required to prevent damage from x-rays, gamma rays, and high energy particulate radiations such as alpha, beta, or neutron.

1. All eye and face protective equipment must meet the standard established by the Occupational Safety and Health Act as detailed in the American National Standard for Eye and Face Protection, ANSI Z87.1 1989.

2. Employees requiring corrective (prescription) lenses will be provided with glasses with sideshields.

3. Employees who do not require corrective lenses will be provided with safety glasses AND safety shields.

7.4.2.2.1 Restrictions

1. Employees with vision in only one eye shall be required to wear eye protection when working in the field.

7.4.2.2.2 Head Protection

Head protection (i.e.; hard hats) is required where employees are subject to head injuries from falling, flying or moving objects, and from bumps caused by working in limited space where the head may come in contact with equipment or objects or when other individuals are working above them.

1. Head protection equipment must be appropriately selected for the hazard and properly maintained.

2. All head protection equipment must meet the standard established by the Occupational Safety and Health Act as detailed in the American National Standard for Safety Requirements for Industrial Head Protection, ANSI Z89.1 1986.

3. Head protection, not specifically assigned to an individual, shall be sanitized after each use or disposable head covering shall be utilized.

7.4.3 Chemical Protective Clothing

Chemical protective equipment is used to minimize or eliminate chemical contact as determined by the HSM. The proper selection of chemical protective equipment is important in preventing exposures. The selection depends on the hazardous conditions, availability, compatibility with other equipment, and performance. An accurate assessment of all these factors must be made before selecting chemical protective equipment.

7.4.3.1 Chemical Protection Selection Criteria

Garments are selected for use by the HSM for resistance to permeation, degradation, and penetration. No material protects against all chemicals and combinations of chemicals, or is an effective barrier to prolonged chemical exposure.

Charts are available from most manufacturers indicating the resistance of their products to degradation, permeation or penetration. Permeation tables should be used in conjunction with degradation tables. Limited permeation data for mixtures is currently available. Chemical mixtures can be significantly more aggressive towards PPE materials than any single component alone.

Selection should be based upon the most hazardous chemicals, potential for skin contact and absorption, and expected concentrations. Sometimes layering of several different types of protective materials or using a material laminated of two or more materials affords the best protection.

When selecting personal protective equipment certain criteria should be evaluated.

1. Concentration of the Chemical - The concentration of the chemical may effect the permeation rate and degradation of the material through the protective clothing.

2. Physical State - The physical state of a chemical determines the exposure route and potential for toxicity.

3. Length of Exposure - The probability of breakthrough of a material is dependent upon the length of time a material is exposed to a chemical. It should be kept in mind that during permeation testing, usually a pure (100% composition) liquid is placed in direct contact with the material, producing a worst-case situation.

4. Abrasion - The use of leather gloves and a heavy apron over regular protective clothing will prevent damage to the PPE and protect against exposures during manual material handling.

5. Dexterity - The dexterity provided by the glove is an important selection criteria, depending upon the task that is being done.

6. Ability to Decontaminate - Selection should not include protective materials that cannot be adequately decontaminated and that must be disposed of after use.

7. Climatic Conditions - Protective clothing adds a burden by adding weight, and restricting movement as well as preventing the natural cooling process, contributing to heat stress. Some materials act differently when they are very hot and very cold.

8. Work Load - The physical requirements of the task must be evaluated. Protective clothing adds physical burden and may make the task more difficult.

7.4.4 Protection Levels

Protection levels are generally based on EPA Levels of Protection: Levels A, B, C and D, as described below. Levels of protection should be selected based on the job function and each ensemble should be tailored to the specific situation. The type of equipment used and the overall level of protection should be reevaluated periodically. Provisions should be made to upgrade or downgrade levels of protection, as necessary.

Reasons to upgrade to a different level:

1. Known or suspected presence of dermal hazards;

2. Occurrence or likely occurrence of gas or vapor emission;

3. Change in work task that will increase contact or potential contact with hazardous materials; and

4. Request of the individual performing the task.

Reasons to downgrade to a different level:

1. New information indicating that the situation is less hazardous than was originally thought;

2. Change in site conditions that decreases the hazard; and

3. Change in work task that will reduce contact with hazardous materials.

7.4.4.1 Level A Protection

Level A protection is physiologically and psychologically stressful. The following conditions suggest a need for Level A protection:

1. Confined facilities where probability of skin contact is high;
2. Sites containing known hazards which are absorbed through the skin;
3. Sites with insufficient information to rule out hazards which are absorbed through the skin;
4. Atmospheres immediately dangerous to life and health (IDLH) -- skin absorption route;
5. Site exhibiting signs of acute mammalian toxicity (e.g., dead animals, illnesses associated with past entry into site by humans);
6. Sites at which sealed drums of unknown materials must be opened;
7. Total atmospheric readings on the PID, FID and similar instruments indicate 500 to 1,000 ppm of unidentified substances; and
8. Extremely hazardous substances (for example: cyanide compounds, concentrated pesticides, DOT Poison "A" materials, suspected carcinogens, and infectious substances) are known or suspected to be present, and skin contact is probable.

Level A protection consists of the following items, as a minimum:

1. Open circuit, pressure-demand SCBA or pressure-demand supplied air respirator with egress cylinder;
2. Totally encapsulated suit;
3. Gloves, inner (surgical type);
4. Gloves, outer, chemical protective;
5. Boots, chemical protective, steel toe and shank; and

6. Communications

7.4.4.2 Level B Protection

Level B protection is selected when the highest level of respiratory protection is needed, but conditions do not warrant Level A.

The following conditions suggest a need for Level B protection:

1. Type and concentration of substances has been identified and requires the highest level of respiratory protection, but exposure to the few unprotected areas of the body (i.e., the back of the neck) is unlikely;

2. IDLH atmospheres, but the substance or concentration does not present a severe skin hazard;

3. Type and concentrations of substances that do not meet the selection criteria permitting the use of air purifying respirators; and

4. Unlikely that the work being done will generate high concentrations of vapors, gases or particulates that will affect the skin or result in skin contact.

Level B protection consists of the following items, as a minimum:

1. Open circuit, pressure-demand SCBA or pressure-demand supplied air respirator with egress cylinder;

2. Chemical protective overalls and long-sleeved jacket or coveralls;

3. Gloves, inner (surgical type);

4. Gloves, outer, chemical protective;

5. Boots, chemical protective, steel toe and shank;

6. Duct tape; and

7. Communications

7.4.4.3 Level C Protection

Level C is selected when air purifying respirators offer adequate respiratory protection and skin contact is unlikely.

Level C protection consists of the following items, as a minimum:

1. Full facepiece air-purifying respirator;
2. Emergency escape respirator (carried, optional);
3. Chemical protective overalls and long-sleeved jacket, or coveralls;
4. Gloves, inner (surgical type);
5. Gloves, outer, chemical protective;
6. Duct tape; and
7. Boots, chemical protective, steel toe and shank.

7.4.4.4 Level D Protection and Modified Level D

Level D is the basic work uniform.

Level D protection consists of the following items:

1. Pants and long sleeve shirt, coveralls or tyvek suit (Modified);
2. Safety boots/shoes;
3. Safety glasses with sideshields (optional); and
4. Hard hat with optional faceshield (Modified)

7.4.5 PPE Use

PPE can offer a high degree of protection only if it is used properly.

1. The PPE must be appropriately selected for the chemical hazard.
2. Protective clothing should be inspected for wear, tears, etc. before each use.
3. Chemical protective clothing must be adequately decontaminated after each use.

7.4.5.1 Donning and Doffing

Exact procedures for removing PPE ensembles must be established, practiced, and followed in order to prevent damage to PPE, reduce/ eliminate migration from the work area and transfer of contaminants to the wearer's body, or others. These procedures should be outlined in the site specific HASP.

7.4.6 Training

Employees required to use PPE must be trained and know the following:

1. When PPE is necessary;
2. What type of PPE is necessary;
3. How to properly don, doff, adjust and wear PPE;
4. The limitations of PPE; and
5. The proper care, maintenance, useful life and disposal of the PPE.

Employer shall verify that each employee has received and understands the required training.

7.4.7 Inspection

An effective PPE inspection program includes the following five parts:

1. Inspection and operational testing of equipment received from the factory or distributor;
2. Inspection of equipment as it is issued to workers;
3. Inspection after use or training and prior to maintenance;
4. Periodic inspection of stored equipment; and
5. Periodic inspection when a question arises concerning the appropriateness of the selected equipment, or when problems with similar equipment arise.

7.4.8 Storage

Clothing must be stored properly to prevent damage or malfunction due to exposure to dust, moisture, sunlight, damaging chemicals, extreme temperatures and impact.

1. Potentially contaminated clothing should be stored in an area separate from street clothing.
2. Potentially contaminated clothing should be stored in a well-ventilated area.
3. Different types and materials of clothing and gloves should be stored separately to prevent issuing the wrong material by mistake.
4. Protective clothing should be folded or hung in accordance with manufacturers' recommendations.

7.4.9 Additional Considerations

1. When foot protection is necessary, chemical and physical hazards should be evaluated and the appropriate protection selected.

2. If hard hats are necessary, chin straps should be used if a person will be stooping over frequently which may cause the hard hat to fall off.

3. In cold temperatures, natural material clothing should be worn under the protective clothing. Protective clothing should be removed prior to allowing a person "to get warm." Applying heat, such as a space heater, is not recommended as the heat may drive the contaminants through.

4. In hot weather, cotton undergarments should be worn to absorb sweat.
5. Body protection should be taped to the boots to prevent anything from running into the boot. Gloves should be taped to prevent substances from entering the top of the glove. Aprons should be taped across the back for added protection.

6. Atmospheric conditions such as precipitation, temperature, wind direction, wind velocity, and pressure effect the behavior of air contaminants or the potential for volatile material becoming airborne.

7.5 References

None

7.6 Attachments

A - Workplace Hazard Assessment Certification
B - Permeation Guide for DuPont Tychem Fabrics
C - Pioneer Industrial Gloves - Chemical Resistance Guide

ATTACHMENT A

Workplace Hazard Assessment Certification

Company: _____

Location: _____

Work Area: _____

Process/Procedure (Job): _____

_____

_____

_____

Hazards/Potential Hazards Assessment:

_____

_____

_____

_____

Certified By: _____ Date: _____

Personal Protective Equipment Required:

	Req.	Description of Minimum PPE Required	Specific Hazard and Source
Eyes	☐		
Face	☐		
Head	☐		
Foot	☐		
Hand	☐		
Body	☐		
Hearing	☐		
Respiratory	☐		

Required PPE Assessment By: _____ Date: _____

ATTACHMENT B

Permeation Guide for DuPont Tychem™ Fabrics

Revised October 1993

This guide replaces all previously published guides and is valid until May 1994.

Call 1-800-44-TYVEK for additional information or updated guides.

How to Use this Permeation Guide

The permeation data is organized by chemical class. The chemical classification system used in this Permeation Guide is defined in ASTM F1186, "Standard Classification System for Chemicals According to Functional Groups." This classification system was developed by ASTM Committee F23 to assist highly trained and skilled individuals in selecting proper chemical protective clothing.

Locate your specific chemical in the Chemical Index on page 2, and note the corresponding Chemical Sub-Class Number. Then locate that Chemical Sub-Class number in the Permeation Data Table starting on page 6.

Many chemicals have several names. If you can't find your chemical in the Chemical Index, check in the synonym list opposite the index. If you still can't find it, call 1-800-44-TYVEK for assistance.

If a specific chemical is not listed in the permeation guide, the user should seek help from a trained and experienced individual in selecting the proper chemical protective garment or have the garment tested for permeation against the specific chemical hazard.

Table of Contents

Independent Testing

All permeation tests are conducted for DuPont by independent testing laboratories. The breakthrough times and permeation rates listed in this guide were determined by ASTM F739, "Test Method for Resistance of Protective Clothing Materials to Permeation by Liquids and Gases."

All permeation tests were conducted with pure chemicals at standard temperature and pressure, unless otherwise specified. The physical phase of each tested chemical (solid, liquid, or gas) is listed in the permeation data table.

Copies of individual laboratory reports are available by calling 1-800-44-TYVEK.

What's New in the DuPont Permeation Guide

The Permeation Guide has been expanded to include more information to assist the user in selecting fabrics for use in chemical environments.

- Columns showing normalized breakthrough time, SDL (system detection limit), and MDPR (minimum detectable permeation rate) have been added to the permeation data table. DuPont is in the process of retesting, where necessary, to fill in any blanks in these columns due to unavailability of the data. In some cases, retesting has resulted in revisions to the data, due to improved sensitivity of analytical systems during the time since the earlier tests were conducted.
- List of synonyms.
- Chemicals added to the Permeation Guide:
  - —4-Chloroaniline
  - —3,4-Dichloroaniline
  - —1,1-Dichlorotetrafluoroethane
  - —Di (2-ethylhexyl) phthalate
  - —Formalin, 10%
  - —Gasoline, unleaded
  - —Glutaraldehyde
  - —Methyl ethyl ketoxime
  - —Methyl t-butyl ether
  - —Parabromofluorobenzene
  - —1,1,1,2-Tetrafluoroethane
  - —Vinyl chloride

WARNING:

- "Tychem" fabrics are not flame resistant and should not be used around heat, flame, sparks, or in potentially flammable or explosive environments.
- Garments made of "Tychem" fabrics should have slip resistant or antislip materials on the outer surface of boots, shoecovers, or other garment surfaces where a concern about slippage exists. For more information, call 1-800-44-TYVEK.

CHEMICAL INDEX

Chemical name	Sub-Class Number	CAS Number
[illegible]etic acid	102	64-19-7
Acetone	391	67-64-1
Acetonitrile	431	75-05-8
Acetyl chloride	111	75-36-5
Acrolein	121	107-02-8
Acrylic acid	102	79-10-7
Acrylonitrile	431	107-13-1
Allyl alcohol	311	107-18-6
Ammonia	350	7664-41-7
Ammonium hydroxide	380	1336-21-6
n-Amyl acetate	222	628-63-7
Aniline	145	62-53-3
Antimony pentachloride	360	7647-18-9
Benzene	292	71-43-2
Benzonitrile	432	100-47-0
Benzoyl chloride	112	98-88-4
Blood (human)	590	N/A
Bromine	330	7726-95-6
1,3-Butadiene	294	106-99-0
n-Butanol	311	71-36-3
Butyl cellosolve	245	111-76-2
Butyl ether	241	142-96-1
Butyraldehyde	121	123-72-8
Carbon disulfide	502	75-15-0
Carbon tetrachloride	261	56-23-5
Chlorine gas	330	7782-50-5
Chloroacetic acid	103	79-11-8
Chloroacetone	391	78-95-5
4-Chloroaniline	145	106-47-8
Chlorobenzene	263	108-90-7
[illegible]-Chloroethanol	315	107-07-3
[illegible]roform	261	67-66-3
[illegible]hlorotoluene	263	95-49-8
[illegible]romic acid	370	1333-82-0
Cresol (mixed isomers)	316	95-48-7
Cyclohexane	291	110-82-7
3,4-Dichloroaniline	145	95-76-1
1,4-Dichloro-2-butene	261	110-57-6
Dichloromethane	261	75-09-2
2,3-Dichloropropene	261	78-88-6
1,1-Dichlorotetrafluoroethane	261	374-07-2
Diesel fuel	291	N/A
Diethyl ether	241	60-29-7
Diethylamine	142	109-89-7
Di (2-ethylhexyl) phthalate	226	117-81-7
N,N-Dimethylacetamide	132	127-19-5
N,N-Dimethylformamide	132	68-12-2
1,1-Dimethylhydrazine	280	57-14-7
4,4'-Dipenyl methane diisocyanate	212	101-68-8
Epichlorohydrin	275	106-89-8
Ethyl acetate	222	141-78-6
Ethyl cellosolve	245	110-80-5
Ethyl cellosolve acetate	245	111-15-9
Ethylbenzene	292	100-41-4
Ethylene dibromide	261	106-93-4
Ethylene dichloride	261	107-06-2
Ethylene diglycol monoethyl ether	245	111-90-0
Ethylene glycol	314	107-21-1
Ethylene oxide	275	75-21-8
Ethylenediamine	152	107-15-3
Fluorobenzene	263	460-06-6
Formaldehyde, 37%	121	50-00-0
Formalin, 10%	121	50-00-0
[illegible] acid	102	64-18-6
[illegible]f 113	261	76-13-1
[illegible]raldehyde	277	98-01-1
Gasohol	590	N/A
Gasoline, leaded	292	N/A
Gasoline, unleaded	292	N/A
Glutaraldehyde	121	111-30-8
Hexamethylenediisocyanate	211	822-06-0
n-Hexane	291	110-54-3
Hydrazine	280	302-01-2
Hydrochloric acid	370	7647-01-0
Hydrocyanic acid	420	74-90-8
Hydrofluoric acid	370	7664-39-3
Hydrogen chloride	350	7647-01-0
Hydrogen fluoride	350	7664-39-3
Hydrogen peroxide	300	7722-84-1
Iodine	330	7553-56-2
Jet A fuel	291	N/A
JP-4	291	N/A
Mercuric chloride	340	7487-94-7
Mercury	330	7439-97-6
Methanol	311	67-56-1
Methylamine	141	74-89-5
Methyl bromide	261	74-83-9
Methyl cellosolve	245	109-86-4
Methyl cellosolve acetate	245	110-49-6
Methyl chloride	261	74-87-3
4,4'-Methylene bis (2-chloroaniline)	153	101-14-4
Methyl ethyl ketone	391	78-93-3
Methyl ethyl ketoxime	590	96-29-7
Methyl isocyanate	211	624-83-9
Methyl methacrylate	223	80-62-6
Methyl t-butyl ether	241	1634-04-4
Mineral spirits	291	N/A
Nicotine	271	54-11-5
Nitric acid	370	7697-37-2
Nitrobenzene	441	98-95-3
Nitrogen dioxide	350	10102-44-0
Nitrogen tetroxide	350	10544-72-6
Nitromethane	441	75-52-5
Oleum	370	8014-95-7
Parabromofluorobenzene	263	460-00-4
PCB	263	11097-69-1
Phenol	316	108-95-2
Phosphoric acid	370	7664-38-2
Phosphorus trichloride	360	7719-12-2
Potassium acetate	340	127-08-2
Potassium chromate	340	7789-00-6
Potassium cyanide	420	15-50-8
1,2-Propylene oxide	275	75-56-9
Sodium cyanide	420	143-33-9
Sodium fluoride	340	7681-49-4
Sodium hydroxide	380	1310-73-2
Sodium hypochlorite	340	7681-52-9
Styrene	292	100-42-5
Sulfur dioxide	350	7446-09-5
Sulfuric acid	370	7664-93-9
1,1,2,2-Tetrachloroethane	261	79-34-5
Tetrachloroethylene	267	127-18-4
1,1,1,2-Tetrafluoroethane	261	811-97-2
Tetrahydrofuran	241	109-99-9
Toluene	292	108-88-3
Toluene-2,4-diisocyanate	212	584-84-9
m-Toluidine	145	108-44-1
o-Toluidine	145	95-53-4
1,2,4-Trichlorobenzene	263	120-82-1
1,1,1-Trichloroethane	261	71-55-6
2,2,2-Trichloroethanol	315	115-20-8
Trichloroethylene	267	79-01-6
Triethylamine	143	121-44-8
2,2,2-Trifluoroethanol	315	75-89-8
Vinyl acetate	222	108-05-4
Vinyl chloride	267	75-01-4
Xylene (mixed isomers)	292	1330-20-7

CHEMICAL SYNONYMS

Synonym	Chemical Name
Acetic acid amyl ester	Amyl acetate
Acetic acid vinyl ester	Vinyl acetate
Acetic ether	Ethyl acetate
Acetonyl chloride	Chloroacetone
Acetylene trichloride	Trichloroethylene
Acroleic acid	Acrylic acid
Acrylaldehyde	Acrolein
Acryl aldehyde	Acrolein
Aroclor 1254	PCB
Aminic acid	Formic acid
1-Amino-2-methylbenzene	o-Toluidine
Aminobenzene	Aniline
1-Amino-4-chlorobenzene	4-Chloroaniline
Aminomethane	Methylamine
Aminotoluene	o-Toluidine
Ammonia aqueous	Ammonium hydroxide
Ammonia gas	Ammonia
Ammonia liquid (28%)	Ammonium hydroxide
Anhydrous ammonia	Ammonia
Azotic acid	Nitric acid
Benzene carbonyl chloride	Benzoyl chloride
Benzene chloride	Chlorobenzene
Bi ethylene	1 3-Butadiene
Bis (2-ethylhexyl) phthalate	Di (2-ethylhexyl) phthalate
Bivinyl	1 3-Butadiene
4-Bromofluorobenzene	Parabromofluorobenzene
Bromomethane	Methyl bromide
1-Butanol	n-Butanol
2-Butanone	Methyl ethyl ketone
2-Butanone oxime	Methyl ethyl ketoxime
2-Butoxy-1-ethanol	Butyl cellosolve
1-Butoxybutane	Butyl ether
Butyl alcohol	n-Butanol
n-Butyl ether	Butyl ether
Butylene oxide	Tetrahydrofuran
1-Butylenedichloride	1 4-Dichloro-2-butene
Carbitol	Ethylene diglycol monoethyl ether
Carbitol cellosolve	Ethylene diglycol monoethyl ether
Carbon bisulfide	Carbon disulfide
Carbon dichloride	1,1,2,2-Tetrachloroethane
Carbon sulfide	Carbon disulfide
Carbona	Carbon tetrachloride
Caustic soda	Sodium hydroxide
Cellosolve	Ethyl cellosolve
Cellosolve acetate	Ethyl cellosolve acetate
Chlorine bleach	Sodium hypochlorite
p-Chloroaniline	4-Chloroaniline
1-Chloro-2,3-epoxypropane	Epichlorohydrin
1-Chloro-2-methylbenzene	o-Chlorotoluene
3-Chloro-1,2-propylene oxide	Epichlorohydrin
Chloroethanoic acid	Chloroacetic acid
Chlorohydric acid	Hydrochloric acid
Chloromethane	Methyl chloride
Chloropropanone	Chloroacetone
Chromium trioxide	Chromic acid

Synonym	Chemical Name
Chromium(VI) oxide	Chromic acid
Clorox	Sodium hypochlorite
Coal naphtha	Benzene
Cyanide	Hydrocyanic acid
Cyanobenzene	Benzonitrile
Cyanomethane	Acetonitrile
Diamine	Hydrazine
1,2-Diaminoethane	Ethylenediamine
Dibromoethane	Ethylene dibromide
Dibutyl ether	Butyl ether
1,2-Dichloroethane	Ethylene dichloride
Dichloropropylene	2,3-Dichloropropene
Dietnylene oxide	Tetrahydrofuran
Dihydrogen dioxide	Hydrogen peroxide
Dimethyl ketone	Acetone
Dimethylacetone amide	Dimethylacetamide
Dimethylbenzene	Xylene
Dimethylene oxide	Ethylene oxide
Dioctyl phthalate	Di (2-ethylhexyl) phthalate
Disulfuric acid	Oleum
Dithiocarbonic anhydride	Carbon disulfide
Dithionic acid	Oleum
DMAC	Dimethylacetamide
DMFA	Dimethylformamide
Dowanol EB	Butyl cellosolve
1,2-Epoxyethane	Ethylene oxide
Epoxypropane	1,2-Propylene oxide
Etanoic acid	Acetic acid
1,2-Ethanediamine	Ethylenediamine
1,2-Ethanediol	Ethylene glycol
Ethanoyl chloride	Acetyl chloride
Ethinyl trichloride	Trichloroethylene
Ethoxyethane	Diethyl ether
2-Ethoxyethanol	Ethyl cellosolve
2-(2-Ethoxyethoxy)ethanol	Ethylene diglycol monoethyl ether
Ethoxyethyl acetate	Ethyl cellosolve acetate
Ethyl benzol	Ethyl benzene
Ethyl carbitol	Ethylene diglycol monoethyl ether
Ethyl ether	Diethyl ether
Ethyl nitrile	Acrylonitrile
Ethylene alcohol	Ethylene glycol
Ethylene chlorohydrin	2-Chloroethanol
Ethylene glycol methyl ether	Methyl cellosolve
Ethylene glycol monomethyl ether	Methyl cellosolve acetate
Ethyl methyl ketoxime	Methyl ethyl ketoxime
Ethylene tetrachloride	Tetrachloroethylene
Ethylic acid	Acetic acid
Fluoric acid	Hydrofluoric acid
Formylic acid	Formic acid
FC 114	1,1-Dichlorotetrafluoroethane
FC 134A	1,1,1,2-Tetrafluoroethane
Fuel oil	Diesel fuel
Fuming sulfuric acid	Oleum
Fural	2-Furaldehyde
2-Furancarbonal	2-Furaldehyde

CHEMICAL SYNONYMS (Cont'd)

Synonym	Chemical Name
Furfural	2-Furaldehyde
Gasoline/alcohol mixture	Gasohol
Glycol chlorohydrin	2-Chloroethanol
Glycol monobutyl ether	Butyl cellosolve
Glycol monoethyl ether acetate	Ethyl cellosolve acetate
HCl gas	Hydrogen chloride
HCN	Hydrocyanic acid
Hexahydrobenzene	Cyclohexane
Hexamethylene	Cyclohexane
Hexanaphthene	Cyclohexane
HF	Hydrogen fluoride
HMDI	Hexamethylenediisocyanate
Hydrochloride	Hydrochloric acid
Hydrogen chloride gas	Hydrogen chloride
Hydrogen cyanide	Hydrocyanic acid
Hydrogen fluoride anhydrous	Hydrogen fluoride
Hydrogen nitrate	Nitric acid
Hydrogen sulfate	Sulfuric acid
Hydroxybenzene	Phenol
Hydroxymethane	Methanol
Isocyanic acid methyl ester	Methyl isocyanate
Kerosene	Jet A fuel
Kwik	Mercury
Lye	Sodium hydroxide
MBOCA	Methylene bis-o-chloroaniline
MDI	4,4'-Diphenyl methane diisocyanate
MDM	N,N-Dimethylformamide
MEK	Methyl ethyl ketone
Methacrylic acid methyl ester	Methyl methacrylate
Methane trichloride	Chloroform
Methanecarboxylic acid	Acetic acid
Methanoic acid	Formic acid
Methyl alcohol	Methanol
2-Methoxyethanol	Methyl cellosolve
2-Methoxyethyl acetate	Methyl cellosolve acetate
Methyl acetone	Methyl ethyl ketone
Methyl cyanide	Acetonitrile
2-Methyl-2-methoxypropane	Methyl t-butyl ether
Methyl ketone	Acetone
1-Methyl-2(3-pyridyl)pyrrolidine	Nicotine
Methylaniline	o-Toluidine
Methylbenzene	Toluene
Methylchloroform	1,1,1-Trichloroethane
Methylene chloride	Dichloromethane
Methylene dichloride	Dichloromethane
Methylene oxide	Formaldehyde
Methylphenol	Cresol
Methyltoluene	Xylene
Mirbane oil	Nitrobenzene
MOCA	4,4'-Methylene bis-o-chloroaniline
Monochloroacetic	Chloroacetic acid
Monochloroacetone	Chloroacetone
Monoethylene glycol	Ethylene glycol
MTBE	Methyl t-butyl ether
Muriatic acid	Hydrochloric acid, 37%
n-Butyl aldehyde	Butyraldehyde

Synonym	Chemical Name
N-Ethylethanamine	Diethylamine
Naphtha	Mineral spirits
Nitrobenzol	Nitrobenzene
Nitrocarbol	Nitromethane
Nitrogen peroxide	Nitrogen dioxide
Oil of vitriol	Sulfuric acid
Orthophosphoric acid	Phosphoric acid
Oxacyclopentane	Tetrahydrofuran
Oxirane	Ethylene oxide
Oxomethane	Formaldehyde
1,1-Oxybisethane	Diethyl ether
PCB	PCB 1254
1,5-Pentanedial	Glutaraldehyde
Perchloroethylene	Tetrachloroethylene
Perclene	1,1,2,2-Tetrachloroethane
Petrol	Gasoline
Petroleum spirits	Mineral spirits
Phenyl chloride	Chlorobenzene
Phenyl cyanide	Benzonitrile
Phenyl hydride	Benzene
Phenylamine	Aniline
Phenylethane	Ethyl benzene
Phenylethene	Styrene
Phenylmethane	Toluene
Phosphorus chloride	Phosphorous trichloride
Polychlorinated biphenyls	PCB 1254
2-Propanone	Acetone
2-Propenal	Acrolein
Propene acid	Acrylic acid
Propenitrile	Acrylonitrile
2-Propenoic acid	Acrylic acid
Propenol	Allyl alcohol
Prussic acid	Hydrocyanic acid
Pyrosulfuric acid	Oleum
Quicksilver	Mercury
Refrigerant 113	Freon 113
Roach salt	Sodium fluoride
Sodium hydrate	Sodium hydroxide
Solvent naphtha	Mineral spirits
Spirit of hartshorn	Ammonia
Sulfurous acid	Sulfur dioxide
TDI	Toluenediisocyanate
Tetrachloromethane	Carbon tetrachloride
TFE	2,2,2-Trifluoroethanol
Toluol	Toluene
Trichloromethane	Chloroform
Triclene	Trichloroethylene
Trifluorotrichloroethane	Freon® 113
VCM	Vinyl chloride
Vinegar naphtha	Ethyl acetate
Vinyl cyanide	Acrylonitrile
Vinylbenzene	Styrene
Vinylbenzol	Styrene
White caustic	Sodium hydroxide
Wood alcohol	Methanol

ASTM Recommended List of Liquid and Gaseous Chemicals for Evaluating Protective Clothing Materials in Testing Programs (ASTM F1001)

This list of chemicals is not inclusive of all chemical challenges or chemical classes. The chemicals were chosen to represent broad ranges of liquid and gaseous chemical classes and properties. Other chemicals, especially those of interest to the manufacturer or user, should be tested in addition to those recommended.

For additional test data on Tychem® 7500 and Tychem® 9400, **call 1-800-44-TYVEK.**

			TYVEK® QC		TYVEK®/ SARANEX® 23-P		TYCHEM™ 7500		BARRICADE®		TYCHEM™ 9400	
			Normalized Breakthrough Time	Permeation Rate	Normalized Breakthrough Time	Permeation Rate	Normalized Breakthrough Time	Permeation Rate	Normalized Breakthrough Time	Permeation Rate	Normalized Breakthrough Time	Permeation Rate
Chemical Name	Class	Physical Phase	(minutes)	(µg/cm²/min)	(minutes)	(µg/cm²/min)	(minutes)	(µg/cm²/min)	(minutes)	(µg/cm²/min)	(minutes)	(µg/cm²/min)
Acetone	Ketones	L	immed.	10	24	1 6	338	0 16	>480	ND	>480	ND
Acetonitrile	Nitriles	L	immed.	16	13	2 8	14	180	>480	ND	>480	ND
Ammonia (anhydrous)	Inorganic Gases and Vapors	G	immed.	3 1	32	0 15	125	0 1	74	0 1	40	0 6
1,3-Butadiene	Hydrocarbons	G	8	12	>480	ND	>480	ND	>480	ND	>480	ND
Carbon disulfide	Sulfur Compounds	L	immed.	high	8	50	>480	ND	>480	ND	>480	ND
Chlorine gas	Elements	G	immed.	50	>480	ND	>480	ND	>480	ND	>480	ND
Dichloromethane	Halogen Compounds	L	immed.	50	7	>50	5	11	>480	ND	234	0 16
Diethylamine	Amines	L	immed.	64	12	>50	>480	ND	>480	ND	>480	ND
N,N-Dimethylformamide	Amides	L	7	0 72	113	0 4	>480	ND	226†	1 7	>480	ND
Ethyl acetate	Esters, Carboxylic	L	immed.	12 7	36†	6 6	>480	ND	>480	ND	>480	ND
Ethylene oxide	Heterocyclic Compounds	G	immed.	168	7	8 4	75	2 7	>480	ND	>480	ND
n-Hexane	Hydrocarbons	L	immed.	high	146	0 48	>480	ND	>480	ND	>480	ND
Hydrogen chloride	Inorganic Gases and Vapors	G	immed.	3 3	>480	ND	180	0 54	>480	ND	>480	ND
Methanol	Hydroxylic Compounds	L	immed.	2 2	>480	ND	71	0 17	156	0 6	65	1 2
Methyl chloride	Halogen Compounds	G	immed.	0 3	>480	ND	>480	ND	>480	ND	>480	ND
Nitrobenzene	Nitro Compounds	L	immed.	18	102	2.3	>480	ND	>480	ND	>480	ND
Sodium hydroxide, 50%	Inorganic Bases	L	>480	ND	>480	ND	>480	ND	>480	ND	>480	ND
Sulfuric acid (conc.)	Inorganic Acids	L	>480	ND	>480	ND	>480	ND	>480	ND	>480	ND
Tetrachloroethylene	Halogen Compounds	L	immed.	410	8	5.7	>480	ND	>480	ND	>480	ND
Tetrahydrofuran	Ethers	L	immed.	183	immed.	>50	316	0.19	>480	ND	>480	ND
Toluene	Hydrocarbons	L	immed.	high	immed.	30	>480	ND	>480	ND	>480	

†Actual breakthrough time. Normalized value not available at time of printing.

ND=none detected > greater than < less than
S=solid L=liquid G=gas

Tyvek and Barricade are registered trademarks of DuPont.

Tychem is a trademark of DuPont.

*Saranex 23-P is a registered trademark of Dow Chemical Company.

Warning:

1. "Tychem" fabrics (Tyvek QC, Tyvek/Saranex 23P, Tychem 7500, Tychem 9400, and Barricade) should not be used around heat, flames, sparks or in potentially flammable or explosive atmospheres.
2. Garments made of "Tychem" fabrics should have slip resistant or antislip materials on the outer surface of boots, shoecovers, or other garment surfaces where a concern about slippage exists. For more information, call 1-800-44-TYVEK.

Class	Sub-Class	Chemical	Physical Phase	TYVEK® QC Breakthrough Time Normalized (min)	TYVEK® QC Breakthrough Time Actual (min)	TYVEK® QC Permeation Rate (µg/cm²/min)	TYVEK® QC SDL (ppm)	TYVEK® QC MDPR (µg/cm²/min)	TYVEK®/SARANEX®23-P Breakthrough Time Normalized (min)	TYVEK®/SARANEX®23-P Breakthrough Time Actual (min)	TYVEK®/SARANEX®23-P Permeation Rate (µg/cm²/min)	TYVEK®/SARANEX®23-P SDL (ppm)	TYVEK®/SARANEX®23-P MDPR (µg/cm²/min)	BARRICADE® Breakthrough Time Normalized (min)	BARRICADE® Breakthrough Time Actual (min)	BARRICADE® Permeation Rate (µg/cm²/min)	BARRICADE® SDL (ppm)	BARRICADE® MDPR (µg/cm²/min)
Acids, Carboxylic	102 Aliphatic and Alicyclic, Unsubstituted	Acetic acid, glacial	L		7	3	0.05			>480	ND	0.3			145	3.9	0.16	
		Acrylic acid	L		7	5.4	0.2			>480	ND	0.3			79	6	0.21	
		Formic acid	L		immed.	0.33	190			>480	ND	0.05			>480	ND	0.01	
	103 Aliphatic and Alicyclic, Substituted	Chloroacetic acid sat	L		>480	ND	0.001		nt	nt	nt	nt	nt	nt	nt	nt	nt	nt
Acid Halides, Carboxylic	111 Aliphatic and Alicyclic	Acetyl chloride	L	nt	nt	nt	nt	nt		37	1.1	280			164	0.89	0.11	
	112 Aromatic	Benzoyl chloride	L	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt		>480	ND	0.12	
Aldehydes	121 Aliphatic and Alicyclic	Acrolein	L	nt	nt	nt	nt	nt	11	11	5.3	0.04	0.1	>480	>480	ND	0.02	0.1
		Butyraldehyde	L	immed.	immed.	22	0.3	0.006	50	47	6.1	0.3	0.006		>480	ND	0.35	
		Formaldehyde, 37%	L		immed.	0.31	0.5	0.14		480	ND	0.5	0.14		>480	ND	1	
		Formalin, 10%	L	>480	immed.	003	01	001	nt	nt	nt	nt	nt	nt	nt	nt	nt	
		Glutaraldehyde 5% aqueous solution	L	>480	>480	ND	1.4	0.02	>480	>480	ND	4	0.04	nt	nt	nt	nt	nt
Amides	132 Aliphatic and Alicyclic	N,N Dimethylacetamide	L	nt	nt	nt	nt	nt		64	?	12			>480	ND	0.26	
		N,N Dimethylformamide	L	7	immed.	0.72	0.01	0.001	113	113	0.4	0.01	0.1		226	1.7	1	
Amines	141 Aliphatic and Alicyclic, Primary	Methylamine	G	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	105	105	40	0.01	0.1
	142 Aliphatic and Alicyclic, Secondary	Diethylamine	L	immed.	immed.	64	0.02		12	10	50	0.02	0.001	>480	>480	ND	0.01	0.001
	143 Aliphatic and Alicyclic, Tertiary	Triethylamine	L	nt	nt	nt	nt	nt		>480	ND	2		nt	nt	nt	nt	nt
	145 Aromatic Primary	Aniline	L		immed.	2.1	0.5	0.14		265	0.53	0.5	0.14		>480	ND	1	
		p-Chloroaniline	L	nt	nt	nt	nt	nt	<4	<4	90	0.04	0.001	344	323	9.4	0.01	0.001
		3,4-Dichloroanilne	L	nt	nt	nt	nt	nt	5	4	17	0.02	0.001	284	216	2.4	0.02	0.001
		m-Toluidine	L	nt	nt	nt	nt	nt	>480	>480	ND	0.01	0.001	nt	nt	nt	nt	nt
		o-Toluidine	L		immed.	1		0.03		255	0.36	1	0.28	>480	>480	ND	0.01	0.001
Polyamines	152 Aliphatic, Alicyclic	Ethylenediamine	L		169	2.8	0.2	1.1		>480	ND	0.6		nt	nt	nt	nt	nt
	153 Aromatic	4,4' Methylene bis (o-chloroaniline)†	L	nt	nt	nt	nt	nt	>480	>480	ND	0.9	0.1	>480	>480	ND	0.9	0.1
Isocyanates	211 Aliphatic and Alicyclic	Hexamethylenediisocyanate	L	nt	nt	nt	nt	nt		>480	ND	0.001			>480	ND	1	
		Methyl isocyanate	L	nt	nt	nt	nt	nt	6	5	99	0.9	0.005	>480	>480	ND	0.8	0.01
	212 Aromatic	4,4' Diphenyl methane diisocyanate	S	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	>480	>480	ND	0.3	0.07
		Toluene-2,4-diisocyanate	L		immed.	42	1			>480	ND	1			>480	ND	1	

†Saturated solution in methanol

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Esters, Carboxylic	222 Acetates	n Amyl acetate	L	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt		>480	ND	0 08	
		Ethyl acetate	L	immed.	immed	12 7	0 11			36	6 6	0 8		>480	>480	ND	0.2	0 01
		Vinyl acetate	L	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	>480	>480	ND	0 01	1
	223 Acrylates and Methacrylates	Methyl methacrylate	L	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	>480	>480	ND	2 7	0 02
	226 Phthalates	Di (2 ethyl hexyl) phthalate	L	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	>480	>480	ND	2	0 07
Ethers	241 Aliphatic and Alicyclic	Butyl ether	L	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt		>480	ND	0 03	
		Diethyl ether	L	nt	nt	nt	nt	nt		immed	1 8	0 1			>480	ND	0 05	
		Methyl t butyl ether	L	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	>480	>480	ND	0 01	.007
		Tetrahydrofuran	L	immed.	immed	183	0 1		immed.	immed	.50	0 01	0 001	>480	>480	ND	0 4	0 008
	245 Glycol Ethers	Butyl cellosolve	L	nt	nt	nt	nt	nt		>480	ND	0 09		nt	nt	nt	nt	nt
		Ethyl cellosolve	L	nt	nt	nt	nt	nt		>480	ND	0 2			>480	ND	0.3	
		Ethyl cellosolve acetate	L	nt	nt	nt	nt	nt		39	1 8	0 6		>480	>480	ND	0 06	0 002
		Ethylene diglycol monoethyl ether	L	nt	nt	nt	nt	nt		>480	ND	8 7		nt	nt	nt	nt	nt
		Methyl cellosolve	L	nt	nt	nt	nt	nt		80	109	100		nt	nt	nt	nt	nt
		Methyl cellosolve acetate	L	nt	nt	nt	nt	nt		260	1 1	30		nt	nt	nt	nt	nt
Halogen Compounds	261 Aliphatic and Alicyclic	Carbon tetrachloride	L	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	>480	>480	ND	0 4	0 015
		Chloroform	L		immed	350	1			immed.	200	1		>480	>480	ND	0 1	0 004
		1 4-Dichloro 2 butene	L		75	250	1		nt	nt	nt	nt	nt	nt	nt	nt	nt	nt
		Dichloromethane	L	immed.	immed.	.50	0 01	0 001	7	immed.	50	0 1	nt	nt	>nt	nt	nt	nt
		2 3 Dichloropropene	L	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	>480	>480	ND	0 03	0 008
		1 1 Dichlorotetrafluoroethane	L	nt	nt	nt	nt	nt	>480	>480	-ND	0 5	0 1	nt	nt	nt	nt	nt
		Ethylene dibromide	L	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	>480	>480	ND	0 01	0 1
		Ethylene dichloride	L	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt		>480	ND	0 07	
		Freon 113	G	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt		>480	ND	0 06	
		Methyl bromide	G	nt	nt	nt	nt	nt		47	0 0003	0 11		nt	nt	nt	nt	nt
		Methyl chloride	G	immed.	immed.	0 3	0 01	0 001	>480	>480	110	0 15	0 006	>480	>480	ND	0.02	0 001
		1 1 2 2 Tetrachloroethane	L	nt	nt	nt	nt	nt		75	12	0 2		>480	>480	ND	0 1	0 007
		1 1 1 2 Tetrafluoroethane	L	nt	nt	nt	nt	nt	>480	>480	ND	2	0 1	nt	nt	nt	nt	nt
		1 1 1-Trichloroethane	L	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt		>480	ND	0 1	

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Halogen Compounds (continued)	263 Aromatic	Chlorobenzene	L	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt		>480	ND	0.02	
		o-Chlorotoluene	L	nt	nt	nt	nt	nt	nt	26	30	0.1			>480	ND	0.002	
		Fluorobenzene	L	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	>480	>480	ND	01	0.1
		Parabromofluorobenzene	L	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	>480	>480	ND	0.03	0.001
		PCB 1254	L	55	20	3.6	2	0.03		>480	ND	0.7	0.2	nt	nt	nt	nt	nt
		50% PCB 1254/50% trichlorobenzene	L	nt	nt	nt	nt	nt		>480	ND	0.7	0.2		>480	ND	0.01	
				See sub-class 590 for data on other PCB mixtures														
		1,2,4-Trichlorobenzene	L		immed.	8.4	0.01	0.001		115	0.9	1	0.28	>480	>480	ND	1	0.28
	267 Vinyl Halides	Tetrachloroethylene	L	immed.	immed.	410	0.1		8	immed.	5.7	0.01	0.001	>480	>480	ND	0.2	0.01
		Trichloroethylene	L	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	>480	>480	ND	0.01	0.1
		Vinyl chloride	G	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	>480	>480	ND	0.01	001
Heterocyclic Compounds	271 Nitrogen, Pyridines	Nicotine	L	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	>480	>480	ND	0.01	0.1
	275 Oxygen, Epoxy Compounds	Epichlorohydrin	L	nt	nt	nt	nt	nt		57	52	11		>480	>480	ND	0.5	0.014
		Ethylene oxide	L	immed.	immed.	168	0.7	0.02	7	6	8.4	0.2		>480	>480	ND	0.3	0.01
		1,2 Propylene oxide	L	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	>480	>480	ND	0.1	0.002
	277 Oxygen, Furan Derivatives	Furaldehyde	L	nt	nt	nt	nt	nt		245	0.2	1	0.28		>480	ND	0.5	0.14
Hydrazines	280 Hydrazines	1,1 Dimethylhydrazine	L	nt	nt	nt	nt	nt		12	6	0.5			>480	ND	5.0	
		Hydrazine	L	nt	nt	nt	nt	nt		>480	ND	1			>480	ND	0.05	
Hydrocarbons	291 Aliphatic and Alicyclic, Saturated	Cyclohexane	L	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	>480	>480	ND	0.1	0.003
		Diesel fuel	L	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt		195	0.09	0.5	0.016
		n-Hexane	L	immed.	immed.	high	0.05		146	7	0.48	0.03	0.001	>480	>480	ND	0.02	0.0004
		Jet A fuel	L	nt	nt	nt	nt	nt		457	2	4		nt	nt	nt	nt	nt
		JP-4	L	nt	nt	nt	nt	nt		12	140	0.06	0.002	>480	>480	ND	0.05	0.002
		Mineral spirits	L		immed.	nm	< 02			>480	ND	10			>480	ND	1.0	
	292 Aromatic	Benzene	L	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt		>480	ND	03	
		Ethylbenzene	L	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt		>480	ND	0.02	
		Gasoline, leaded	L	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt		>480	ND	0.06	
		Gasoline, unleaded	L	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	>480	>480	ND	0.01	001
		Styrene	L	nt	nt	nt	nt	nt		43	70	2			>480	ND	0.05	
		Toluene	L	immed.	immed.	high	0.03			immed.	30		0.8	>480	>480	ND	0.03	0.001
		Xylene (mixed isomers)	L	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt		>480	ND	0.1	
	294 Alkenes (Olefins)	1,3 Butadiene	G	8	immed.	12	0.01	0.001	>480	>480	ND	0.01	0.001	>480	>480	ND	0.01	0.001

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				Breakthrough Time		Permeation Rate			Breakthrough Time		Permeation Rate			Breakthrough Time		Permeation Rate		
				Normalized (min)	Actual (min)	(µg/cm²/min)	SDL (ppm)	MDPR (µg/cm²/min)	Normalized (min)	Actual (min)	(µg/cm²/min)	SDL (ppm)	MDPR (µg/cm²/min)	Normalized (min)	Actual (min)	(µg/cm²/min)	SDL (ppm)	MDPR (µg/cm²/min)
Peroxides	300 Peroxides	Hydrogen peroxide 30%	L	>480	>480	ND	7	0.1	nt	nt	nt	nt	nt	>480	>480	ND	0.01	0.1
Hydroxylic Compounds	311 Aliphatic and Alicyclic Primary	Allyl Alcohol	L	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	>480	>480	ND	0.01	0.1
		n-Butanol	L		3	1.6	0.06		nt	nt	nt	nt	nt		>480	ND	0.01	0.1
		Methanol	L	immed.	immed	2.2	0.18		>480	>480	ND	0.01	0.001	156	147	0.6	1	0.009
	314 Aliphatic and Alicyclic Polyols	Ethylene glycol	L		>480	ND	1			>480	ND	1	0.33	nt	nt	nt	nt	nt
	315 Aliphatic and Alicyclic Substituted	2 Chloroethanol	L		3	3.1	0.06		nt	nt	nt	nt	nt	>480	>480	ND	0.4	0.008
		2,2,2-Trichloroethanol	L	nt	nt	nt	nt	nt		19	13.2	140		>480	>480	ND	0.2	0.01
		2,2,2-Trifluoroethanol	L		6	high	0.03		nt	nt	nt	nt	nt	>480	>480	ND	0.05	0.001
	316 Aromatic Phenols	Cresol (mixed isomers)	L	112	8	0.43	0.01	0.001	>480	153	0.17	0.01	0.001	nt	nt	nt	nt	nt
		Phenol 85%	L		immed	0.4	1	0.28		>480	ND	1	0.28		>480	ND	1	
Elements	330 Elements	Bromine	L		immed	high	3100		nt	nt	nt	nt	nt		9	520	0.3	
		Chlorine (20ppm)	G		>480	ND	0.1			>480	ND	0.1		nt	nt	nt	nt	nt
		Chlorine gas	G	immed.	immed	.50	3	0.2	>480	>480	ND	12	0.7	>480	>480	ND	4	0.2
		Iodine	S		440	30	0.5			>480	ND	70		nt	nt	nt	nt	nt
		Mercury	L	nt	nt	nt	nt	nt		210	<.001	0.006			>480	ND	0.0003	
Inorganic Salts (Solutions)	340 Inorganic Salts (Solutions)	Mercuric chloride sat	L	nt	nt	nt	nt	nt		>480	ND	0.3	0.28		>480	ND	0.3	0.28
		Potassium acetate, sat	L	nt	nt	nt	nt	nt		>480	ND	0.5	0.51		>480	ND	0.5	0.49
		Potassium chromate sat	L	nt	nt	nt	nt	nt		>480	ND	0.5	0.51		>480	ND	0.5	0.51
		Sodium fluoride sat	L	nt	nt	nt	nt	nt		>480	ND	0.3	0.28	nt	nt	nt	nt	nt
		Sodium hypochlorite, 5.25%	L		>480	ND	0.05			>480	ND	0.05		nt	nt	nt	nt	nt
Inorganic Gases and Vapors	350 Inorganic Gases and Vapors	Ammonia anhydrous	G	immed.	immed	3.1	0.04	0.001	32	8	0.15	0.05	0.001	74	43	0.1	0.02	0.001
		Hydrogen chloride	G	immed.	immed	9.3	0.4	0.1	>480	>480	ND	0.4	0.1	>480	>480	ND	0.4	0.1
		Hydrogen fluoride	G		7	6	0.2			20	3	0.2		106	91	357	0.007	0.007
		Nitrogen dioxide	G	nt	nt	nt	nt	nt		>480	ND	0.003		nt	nt	nt	nt	nt
		Nitrogen tetroxide	G	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt		24	66	0.03	
		Sulfur dioxide	G		immed	29	3	0.14	>480	>480	ND	0.1	0.1		>480	ND	0.04	
Inorganic Acid Halides	360 Inorganic Acid Halides	Antimony pentachloride	L	nt	nt	nt	nt	nt	>480	>480	ND	1	0.1	nt	nt	nt	nt	nt
		Phosphorus trichloride	L	nt	nt	nt	nt	nt	20	20	28.3	5	0.1	>480	>480	ND	0.5	0.1
Inorganic Acids	370 Inorganic Acids	Chromic acid	L	nt	nt	nt	nt	nt	>480	>480	ND	1	0.1	nt	nt	nt	nt	nt
		Hydrochloric acid, 37%	L	86	86	1.1	0.02	0.1	>480	>480	ND	0.04	0.036		>480	ND	0.006	
		Hydrofluoric acid, 50%	L		180	0.08	0.02	0.024	>480	>480	ND	0.02	0.024		>480	ND	0.01	
		Hydrofluoric acid 70%	L	nt	nt	nt	nt	nt	immed	immed.	0.6	1	0.1	nt	nt	nt	nt	nt

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Inorganic Acids (continued)	370 Inorganic Acids	Hydrofluoric acid, 92% (90°C)	L	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt		67	2.8	0.02	0.07
		Nitric acid, 70%	L		397	0.5	0.04	0.19		>480	ND	0.1	0.13		>480	ND	0.1	0.13
		Oleum, 40% free SO	L		235	0.2	0.04	0.04	>480	>480	ND	0.04	0.04	>480	>480	ND	0.04	0.04
		Phosphoric acid, 85%	L	nt	nt	nt	nt	nt		>480	ND	0.2	0.18		>480	ND	0.2	0.18
		Sulfuric acid, conc	L	>480	>480	ND	1	0.1	>480	>480	ND	1	0.1	>480	>480	ND	1	0.1
Inorganic Bases	380 Inorganic Bases	Ammonium hydroxide, 28%	L	immed.	immed.	62	17000		>480	>480	ND	1	0.1		100	1.1	0.07	
		Sodium hydroxide, 50%	L	>480	>480	ND	1	0.1	>480	>480	ND	1	0.1	>480	>480	ND	1.0	0.1
		Sodium hydroxide, sat	L	>480	>480	ND	1	0.1	>480	>480	ND	1	0.1	nt	nt	nt	nt	nt
Ketones	391 Aliphatic and Alicyclic	Acetone	L	immed.	immed.	10	0.11		24	15	1.6	0.1	0.002	>480	>480	ND	0.1	0.002
		Chloroacetone	L	nt	nt	nt	nt	nt	>480	360	0.1	0.06	0.001	nt	nt	nt	nt	nt
		Methyl ethyl ketone	L	nt	nt	nt	nt	nt		29	7.8	4.1		>480	>480	ND	0.3	0.007
Inorganic Cyanides	420 Inorganic Cyanides	Hydrocyanic acid	L		60	110	300		nt	nt	nt	nt	nt	135	108	0.5	0.3	0.008
		Potassium cyanide, 10%	L	>480	>480	ND	1	0.1	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt
		Sodium cyanide, 95%	L	nt	nt	nt	nt	nt		>480	ND	0.3	0.28		>480	ND	0.3	
Nitriles	431 Aliphatic and Alicyclic	Acetonitrile	L	immed.	immed.	16	0.23		13	11	2.8	0.01	0.001	>480	>480	ND	0.4	0.004
		Acrylonitrile	L		5	0.1	1000			23	0.1	1000			>480	ND	0.03	
	432 Aromatic	Benzonitrile	L	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt		>480	ND	0.15	
Nitro Compounds	441 Unsubstituted	Nitrobenzene	L	immed.	immed.	18	0.01	0.001	102	78	2.3	0.03	0.001	>480	>480	ND	0.02	0.001
		Nitromethane	L	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt		>480	ND	0.3	
Sulfur Compounds	502 Sulfides, Disulfides	Carbon disulfide	L	immed.	immed.	high	0.11		8	immed.	~50	0.01	0.001	>480	>480	ND	0.1	0.003
Miscellaneous (Not classified)	590 Miscellaneous	Blood (human)	L		>480	ND	1		nt	nt	nt	nt	nt	nt	nt	nt	nt	nt
		Gasohol	L	immed.	immed.	7.8	0.2	0.002	>480	>480	ND	0.2	0.003	244	170	0.2	0.4	0.011
		Methyl ethyl ketoxime	L	nt	nt	nt	nt	nt	>480	>480	ND	0.01	0.1	>480	>480	ND	0.01	0.1
		PCB 50%, mineral oil 50%	L	nt	nt	nt	nt	nt		>480	ND			nt	nt	nt	nt	nt
		PCB 1%, mineral spirits 99%	L	nt	nt	nt	nt	nt		>480	ND			nt	nt	nt	nt	nt
		PCB 4%, TCB 6%, min. spir. 90%	L	nt	nt	nt	nt	nt		60	0.01	0.001		nt	nt	nt	nt	nt

ND=none detected nt=not tested > greater than < less than S=solid L=liquid G=gas sat.=saturated solution in water nm=not measured

Tyvek and Barricade are registered trademarks of DuPont Tychem is a trademark of DuPont

*Saranex 23-P is a registered trademark of Dow Chemical Company.

Warning:

1. "Tychem" fabrics (Tyvek QC, Tyvek/Saranex 23P, Tychem 7500, Tychem 9400, and Barricade) should not be used around heat, flames, sparks or in potentially flammable or explosive atmospheres.
2. Garments made of "Tychem" fabrics should have slip resistant or antislip materials on the outer surface of boots, shoe-covers, or other garment surfaces where a concern about slippage exists. For more information, call 1-800-44-TYVEK.

How Permeation Tests are Conducted

Permeation is the process by which a chemical moves through protective clothing material on a molecular level. Permeation tests are conducted following the ASTM F739 test method: "Test Method for Resistance of Protective Clothing Materials to Permeation by Liquids and Gases." The outside surface of a test fabric is exposed to a challenge chemical using a special test cell (see Figure 1).

Breakthrough to the inside fabric surface is monitored by sampling the collection side of the cell and analytically determining when the chemical has permeated the fabric. Breakthrough time is the average elapsed time between initial contact of the chemical with the outside surface of the fabric and detection of the chemical on the inside surface of the fabric. Permeation rate is the average constant rate of permeation that occurs after breakthrough when the chemical contact is continuous and all forces affecting permeation have reached equilibrium.

ASTM F739 Test Cell

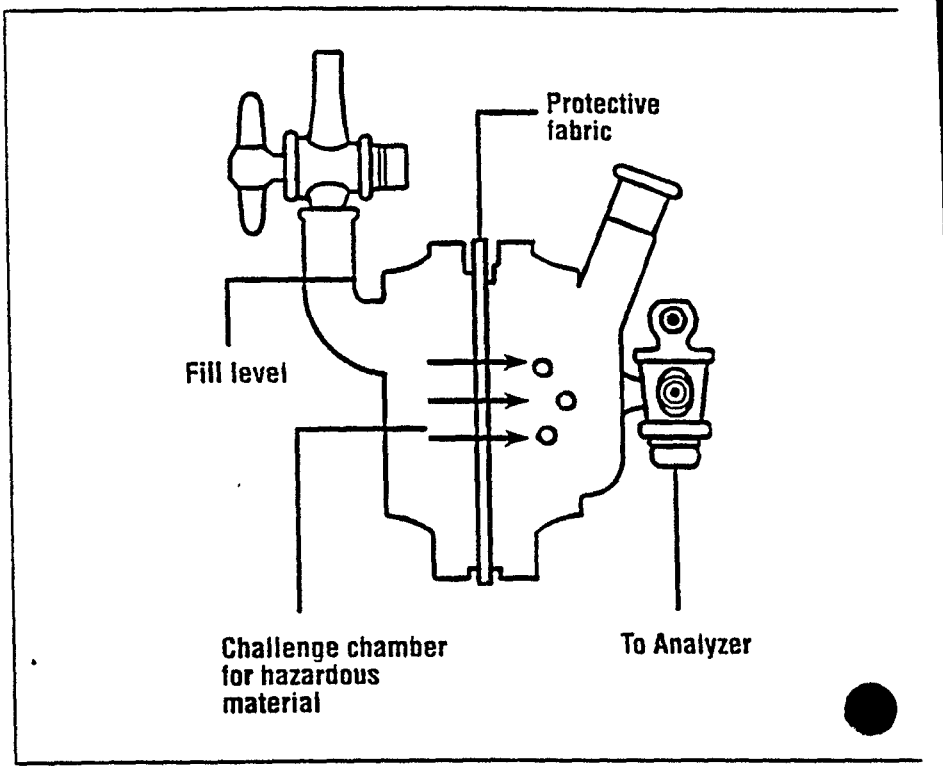

Figure 1

Definitions of Terms

Actual breakthrough time: the average elapsed time between initial contact of the chemical with the outside surface of the fabric and detection of the chemical on the inside surface of the fabric. DuPont permeation tests are run for 480 minutes to simulate a typical 8-hour work shift, unless otherwise specified in this guide. If a breakthrough time is shown as >480, this means that no breakthrough was detected during the 480-minute test period. If a breakthrough time is shown as immediate, this means that chemical breakthrough was detected when the first collection medium sample was analyzed.

CAS number: Chemical Abstract Service Registry Number. The number in format "xxxxxx-xx-x" is unique for each chemical.

MDPR (minimum detectable permeation rate): the minimum permeation rate that can be detected by the analytical system.

Normalized breakthrough time: a calculation, using actual test results, to determine the time at which the permeation rate reaches 0.1 µg/cm²/min. Normalized breakthrough times are useful for comparing barrier performance of different fabrics.

Permeation: the process by which a chemical moves through a protective clothing material on a molecular level.

Permeation rate: the average constant rate of permeation that occurs after breakthrough when the chemical contact is continuous and all forces affecting permeation have reached equilibrium.

Physical phase: phase (solid, liquid, or gas) of a chemical as tested.

SDL (system detection limit): the minimum amount of chemical breakthrough that can be detected by the analytical system. Lower SDLs result in lower (or earlier) breakthrough times.

New from DuPont!

Introducing the Tychem family of fabrics for limited-use protective apparel.

This line of chemical protective fabrics reflects DuPont's ongoing commitment to continually improve and broaden our product offering to meet industry needs for quality, high-performance limited-use protective garments.

Tyvek® QC

Tyvek QC offers splash protection against many inorganic acids, bases and other liquid chemicals such as pesticides. This fabric is made from Tyvek that has been "quality coated" with 1.25 mils polyethylene. Tyvek QC is available in yellow, white or gray.

Tyvek®/Saranex* 23-P

Tyvek laminated with Saranex 23-P offers effective protection against a broader range of chemicals than Tyvek QC and is the only Saranex 23-P laminated fabric for which DuPont provides permeation data and technical support. This fabric is lightweight and offers economical protection. It is available in white or gray.

Tychem™ 7500

This fabric provides a higher level of chemical splash protection than Tyvek laminated with Saranex 23-P. Tychem 7500 also features higher tensile and burst strengths. Tychem 7500 is available in light blue and meets all fabric requirements of NFPA 1993.

Barricade®

Barricade, a multilayer laminate, provides excellent protection against liquid chemicals and is used in Haz-Mat, industrial and other chemical applications. Barricade is strong, durable and offers the low cost, convenience and safety of a limited-use fabric. Barricade is available in yellow and meets all fabric requirements of NFPA 1993.

Tychem™ 9400

This state-of-the-art fabric provides excellent chemical protection against a broad range of chemicals. It is more durable than Barricade and features greater puncture- and tear-resistance with the convenience and safety of a limited-use fabric. Tychem 9400 is available in yellow and meets all fabric requirements of NFPA 1993.

For more information about DuPont's family of fabrics for limited-use protective apparel, call **1-800-44-TYVEK.**

Warning:

1. "Tychem" fabrics (Tyvek QC, Tyvek/Saranex 23P, Tychem 7500, Tychem 9400, and Barricade) should not be used around heat, flames, sparks or in potentially flammable or explosive atmospheres.
2. Garments made of "Tychem" fabrics should have slip resistant or antislip materials on the outer surface of boots, shoecovers, or other garment surfaces where a concern about slippage exists. For more information, call 1-800-44-TYVEK.

DUPONT

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ATTACHMENT C

CHEMICAL RESISTANCE GUIDE FOR PIONEER INDUSTRIAL GLOVES

CHEMICAL TESTED	[illegible] NITRILE							STANZOIL® NEOPRENE							NATURAL RUBBER							PYLOX® PVC						
	DEGRADATION RATING				PERMEATION BREAKTHROUGH			DEGRADATION RATING				PERMEATION BREAKTHROUGH			DEGRADATION RATING				PERMEATION BREAKTHROUGH			DEGRADATION RATING				PERMEATION BREAKTHROUGH		
	Time In Min.				BTT	LDL	Rate	Time In Min.				BTT	LDL	Rate	Time In Min.				BTT	LDL	Rate	Time In Min.				BTT	LDL	Rate
	5	30	60	240	Min	PPM	MG/M²/SEC	5	30	60	240	Min	PPM	MG/M²/SEC	5	30	60	240	Min	PPM	MG/M²/SEC	5	30	60	240	Min	PPM	MG/M²/SEC
ACETALDEHYDE	NT				NT			E	E	E	E	21	.1	18	E	E	E	E	2	.4	13	NT				NT		
ACETIC ACID GLACIAL	NT				118	.1	221	NT				NT			NT				21	.1	2	NT				85	.1	.3
ACETIC ACID 50%	E	E	E	E	>480	.02	ND	E	E	E	E	>480	.1	ND	E	E	E	E	31	.02	3	E	E	E	E	47	.02	.06
ACETONE	G	P	P	P	NT			E	E	E	E	12	—	35	E	E	E	E	7	.05	5	G	P	P	P	<1	—	#
ACETONITRILE	NT				NT			E	E	E	E	40	—	7	NT				NT			NT				NT		
AMMONIUM HYDROXIDE 29%	E	E	E	E	>480	1.0	ND	E	E	E	E	>480	1.0	ND	E	E	E	E	58	1.0	18	E	E	E	E	>480	1.0	ND
ANILINE	G	G	P	P	72	.001	3	E	E	E	E	>480	.005	ND	E	E	E	E	>480	.008	ND	E	E	G	G	>480	.009	ND
AROCLOR 1254/50% TCB	NT				343	1.0	36	NT				>480	1.0	ND	NT				NT			NT				NT		
BENZENE	E	F	P	P	27	.03	97	NT				16	—	133	NT				NT			NT				2	—	250
BENZENE CHLORIDE	NT				15	—	160	NT				NT			NT				NT			NT				NT		
BIS (2-HYDROXYETHYL) AMINE	E	E	E	E	>480	1.1	ND	E	E	E	E	>480	1.1	ND	E	E	E	E	>480	1.1	ND	E	E	E	E	>480	1.1	ND
2-BUTANONE	NT				6	—	87	E	G	G	G	22	—	155	E	E	G	G	6	—	87	NT				1	—	#
2-BUTOXYETHANOL	E	E	E	E	>480	.5	ND	E	E	E	E	147	1.0	5	E	E	E	E	12	1.0	27	NT				NT		
BUTYL ACETATE	E	G	F	F	101	.1	24	NT				52	—	53	NT				NT			NT				NT		
BUTYL CELLOSOLVE	E	E	E	E	>480	.5	ND	E	E	E	E	147	1.0	5	E	E	E	E	12	1.0	27	NT				NT		
CARBOLIC ACID	NT				>480	—	ND	E	E	E	E	>480	.2	ND	E	E	E	G	>480	.06	ND	NT				32	—	13
CARBON DICHLORIDE *(CARBON BICHLORIDE)*	E	G	G	F	373	.0002	4.5	NT				28	.0002	75.5	NT				NT			NT				NT		
CARBON DISULFIDE *(CARBON BISULFIDE)*	E	G	F	F	20	.2	86	NT				NT			NT				NT			NT				NT		
CARBON TETRACHLORIDE	E	E	G	F	341	1.0	8	G	F	P	P	31	—	252	NT				NT			NT				NT		
CELLOSOLVE	E	E	E	G	416	.03	4	E	E	E	E	352	.06	3	E	E	E	E	10	.03	2	NT				NT		
CELLOSOLVE ACETATE	E	G	F	P	162	.1	12	E	G	G	G	76	.07	42	E	E	G	G	13	—	—	NT				NT		
CHLOROBENZENE	NT				15	—	160	NT				NT			NT				NT			NT				NT		
CHLOROFORM	NT				NT			F	P	P	P	12	.2	228	NT				NT			NT				NT		
CHLOROTHENE	F	P	P	P	131	.05	44	F	P	P	P	27	—	197	NT				NT			NT				NT		
o-CHLOROTOLUENE	NT				52	—	164	NT				NT			NT				NT			NT				NT		
p-CHLOROTOLUENE	NT				25	—	148	NT				NT			NT				NT			NT				NT		
CHROMIC ACID 50%	E	E	E	E	>175	.1	#	NT				NT			NT				NT			NT				>480	.1	ND
m-CRESOL *(3-CRESOL)*	E	G	E	E	210	5.0	21	E	E	E	E	480	5.0	ND	E	E	E	G	150	5.0	9	E	E	E	E	120	2.0	3

CYCLOHEXANE																																			
DIAMINE	E	E	E	E	>480	.02		E	E		E	159	.03	7		NT				NT				NT				NT				—	17
1,2-DICHLOROBENZENE *(o-DICHLOROBENZENE)*	E	E	E	E	>480	.7	ND	E	E		E	>480	.7	ND	E	E	E	E	218	.7	2	E	E	E	E	>480	.7	ND						
1,3-DICHLOROBENZENE	NT				37	—	190	NT				NT				NT				NT				NT				NT						
1,2-DICHLOROETHANE	G	F	P	P	73	.3	29	NT				NT				NT				NT				NT				NT						
DICHLOROMETHANE	P	P	P	P	16	.06	292	E	P	P	P	33	.09	247		NT				NT				NT				NT						
DIETHANOLAMINE	NT				NT			G	F	F	F	6	—	239		NT				NT				NT				NT						
DIETHYL ETHER	E	E	E	E	>480	1.1	ND	E	E	E	E	>480	1.1	ND	E	E	E	E	>480	1.1	ND	E	E	E	E	>480	1.1	ND						
1,4-DIETHYLENE DIOXIDE	E	E	E	E	64	.1	13	E	E	E	E	18	.1	81		NT				NT				NT				NT						
DIMETHYL ACETAMIDE *(DMAC)*	NT				NT			NT				28	—	62		NT				NT				NT				6	—	250				
DIMETHYL FORMAMIDE *(DMF)*	G	P	P	P	28	.001	#	E	G	G	P	NT			E	F	F	F		NT		G	#	#	#	20	.005	#						
DIMETHYL SULFOXIDE *(DMSO)*	NT				35	.2	41	E	E	E	E	110	.1	41	E	E	E	E	67	.1	41		NT				NT						
1,4-DIOXANE	E	E	G	P	0	.004	1	E	E	E	E	0	.004	0	E	E	E	E	240	.004	0	E	E	G	G	60	.004	0						
2-ETHOXYETHANOL	NT				NT			NT				28	—	62		NT				NT				NT				6	—	250				
2-ETHOXYETHYL ACETATE	E	E	E	G	416	.03	4	E	E	E	E	352	.06	3	E	E	E	E	10	.03	2		NT				NT						
ETHYL ACETATE	E	G	F	P	162	.1	12	E	G	G	G	76	.07	42	E	E	G	G	13	—	—		NT				NT						
ETHYL ALCOHOL *(ETHANOL)*	NT				NT			E	G	G	G	34	.08	178		NT				NT				NT				NT						
ETHYL ETHER	E	E	E	E	>480	.002	ND	E	E	E	E	>480	.002	ND	E	E	E	E	>480	.02	ND	E	E	E	E	20	—	5						
ETHYLENE DICHLORIDE	E	E	E	E	64	.1	13	E	E	E	E	18	.1	81		NT				NT				NT				NT						
ETHYLENE GLYCOL	P	P	P	P	16	.06	292	E	P	P	P	33	.09	247		NT				NT				NT				NT						
ETHYLENE OXIDE	E	E	E	E	>480	—	ND	E	E	E	G	>480	—	ND	E	E	E	E	>480	—	ND	E	E	E	E	>480	—	ND						
FORMALDEHYDE 37%	NT				32	.3	21	NT				31	3.0	10		NT				NT				NT				NT						
FORMALIN SOLUTION	E	E	E	E	>480	8.0	ND	E	E	E	E	>480	3.0	ND	E	E	E	E	>480	.01	ND	G	G	G	G	>480	.01	ND						
FREON 12	E	E	E	E	>480	8.0	ND	E	E	E	E	>480	3.0	ND	E	E	E	E	>480	.01	ND	G	G	G	G	>480	.01	ND						
FREON TF	NT				>480	.08	ND	NT				>480	.03	ND		NT				NT				NT				NT						
GASOLINE	E	E	E	E	>480	.01	ND	E	E	E	E	>480	.2	ND		NT				NT				NT				11	—	32				
HEPTANE	E	E	E	E	>480	.1	ND	E	E	E	E	96	.2	16		NT				NT				NT				NT						
HEXANE	E	E	E	E	2	.01	.003	E	E	E	E	124	.02	2		NT				NT				NT				NT						
HYDRAZINE	E	E	E	E	>480	.08	ND	E	E	E	E	39	.08	6		NT				NT				NT				NT						
HYDROCHLORIC ACID 37.5% *(HCL)*	E	E	E	E	>480	.7	ND	E	E	E	E	>480	.7	ND	E	E	E	E	218	.7	2	E	E	E	E	>480	.7	ND						
HYDROFLUORIC ACID 48% *(HF)*	E	E	E	E	>480	.4	ND	E	E	E	E	>480	4.0	ND	E	E	E	E	211	4.0	218	E	E	E	E	>480	4.0	ND						
ISOAMYL ACETATE	E	E	E	G	134	.001	5	E	E	E	E	>480	1.0	ND	E	E	E	E	>480	1.0	ND	E	E	E	E	110	1.0	0						
ISOPROPYL ALCOHOL *(ISOPROPANOL, IPA)*	NT				NT			NT				30	—	52		NT				NT				NT				5	—	267				
ISOPROPYLBENZENE	E	E	E	E	>480	.05	ND	E	E	E	E	>60	.0006	ND	E	E	E	E	>60	—	ND	E	E	E	E	208	—	0						
KEROSENE	E	E	E	G	271	.03	8	E	G	F	P	41	.4	36		NT				NT				NT				NT						
METHANE DICHLORIDE	E	E	E	E	>480	.007	ND	E	E	E	E	>480	.00005	ND		NT				NT				NT				NT						
METHYL ALCOHOL *(METHANOL)*	NT				NT			G	F	F	F	6	—	239		NT				NT				NT				NT						
METHYLCHLOROFORM	E	E	E	E	118	.08	3	E	E	E	E	>60	—	ND	E	E	E	E	>60	—	ND		NT				NT				3	—	3			
METHYL CYANIDE	F	P	P	P	131	.05	44	F	P	P	P	27	—	197		NT				NT				NT				NT					NT		
METHYL ETHYL KETONE *(MEK)*	NT				NT			E	E	E	E	40	—	7		NT				NT				NT				NT					NT		
METHYL IODIDE	NT				6	—	87	E	G	G	G	22	—	155	E	E	G	G	6	—	87		NT				NT				1	—	[redacted]			
	NT				NT			NT				[redacted]	—	617		NT				NT				NT				NT					NT		

METHYL ETHYL KETONE *(MEK)*	NT				[illegible]	—	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]							[illegible]						
METHYL IODIDE	NT				NT			NT				12	—	617	NT				NT			NT				1	—	#
METHYLENE CHLORIDE	NT				NT			G	F	F	F	6	—	239	NT				NT			NT				NT		
m-METHYLPHENOL *(3-METHYLPHENOL)*	E	G	F	F	210	5.0	21	E	E	E	E	>480	5.0	ND	E	E	E	G	150	5.0	2	E	E	E	E	150	5.0	6
MINERAL SPIRITS	E	E	E	E	>480	.02	ND	E	E	E	E	126	.002	2	NT				NT			NT				NT		
MURIATIC ACID	E	E	E	E	>480	.4	ND	E	E	E	E	>480	4.0	ND	E	E	E	E	211	4.0	218	E	E	E	E	>480	4.0	ND
NAPHTHA	E	E	E	E	>480	.02	ND	E	E	E	E	126	.002	2	NT				NT			NT				NT		
NITRIC ACID 50%	E	G	G	P	72	.07	201	E	E	E	E	>480	.0003	ND	E	E	E	G	233	.1	#	E	E	E	E	114	.08	0
NITROBENZENE	G	P	P	P	60	1.0	15	E	E	G	P	60	1.0	20	NT				NT			NT				NT		
OLEIC ACID	E	E	E	E	NT			E	E	E	E	NT			NT				NT			NT				NT		
PENTANE	NT				NT			NT				38	—	3	NT				NT			NT				9	—	17
PERCHLOROETHYLENE	E	G	G	F	373	.0002	4.5	NT				28	.0002	75.5	NT				NT			NT				NT		
PETROLEUM ETHER	E	E	E	E	>480	.02	ND	E	E	E	E	126	.002	2	NT				NT			NT				NT		
PHENOL SAT.	NT				>480	—	ND	E	E	E	E	>480	.2	ND	E	E	E	G	>480	.06	ND	NT				32	—	13
PHOSPHORIC ACID 85%	E	E	E	E	>480	.04	ND	E	E	E	E	>480	.04	ND	E	E	E	E	>480	.04	ND	E	E	E	E	>480	.04	ND
POLYCHLORINATED BIPHENYLS *(PCBs)*/50% TCB	NT				343	1.0	36	NT				>480	1.0	ND	NT				NT			NT				NT		
POTASSIUM HYDROXIDE 50% *(KOH)*	E	E	E	E	>480	.4	ND	E	E	E	E	>480	.3	ND	E	E	E	E	>480	.3	ND	E	E	E	E	>480	.4	ND
PYRIDINE	NT				NT			NT				26	—	117	NT				NT			NT				1	—	#
RULE 66 SOLVENT	E	E	E	E	>480	.001	ND	E	E	E	E	332	.03	0	NT				9	.002	21	E	E	E	E	42	.02	10
SODIUM HYDROXIDE 50% *(NAOH)*	E	E	E	E	>480	.1	ND	E	E	E	E	>480	.1	ND	E	E	E	E	>480	.1	ND	E	E	E	E	>480	.04	ND
SULFURIC ACID 50%	E	E	E	E	>480	.04	ND	E	E	E	E	>480	.04	ND	E	E	E	E	>480	.1	ND	E	E	E	E	>480	.04	ND
1,1,2,2-TETRACHLOROETHANE	NT				NT			NT				18	—	233	NT				NT			NT				6	—	417
1,1,2,2-TETRACHLOROETHYLENE	E	G	G	F	373	.0002	4.5	NT				28	.0002	75.5	NT				NT			NT				NT		
TETRAHYDROFURAN *(THF)*	G	P	P	P	17	.08	671	E	P	P	P	11	.08	671	NT				NT			NT				1	—	#
TOLUENE *(TOLUOL)*	G	P	P	P	28	.002	25	NT				14	—	376	NT				NT			NT				3	—	350
TOLUENE DIISOCYANATE *(TDI)*	E	F	F	P	>480	.3	ND	NT				NT			E	E	G	F	>480	.1	ND	E	G	F	P	>480	.06	ND
1,1,1-TRICHLOROETHANE	F	P	P	P	131	.05	44	F	P	P	P	27	—	197	NT				NT			NT				NT		
TRICHLOROETHYLENE *(TCE)*	P	P	P	P	9	.002	62	NT				11	—	661	NT				NT			NT				NT		
TRICHLOROTRIFLUOROETHANE	E	E	E	E	>480	.01	ND	E	E	E	E	>480	.2	ND	NT				NT			NT				11	—	32
TRIETHANOLAMINE *(TEA)*	E	E	E	E	>480	5.0	ND	E	E	E	E	>480	5.0	ND	E	E	E	E	>480	5.0	ND	E	E	E	E	>480	6.0	ND
TRIFLUOROETHANOL	NT				NT			NT				>60	—	ND	NT				NT			NT				15	—	211
TRIHYDROXYTRIETHYLAMINE	E	E	E	E	>480	5.0	ND	E	E	E	E	>480	5.0	ND	E	E	E	E	>480	5.0	ND	E	E	E	E	>480	6.0	ND
TURPENTINE	E	E	E	E	>480	.0009	ND	E	E	E	E	>480	.02	ND	NT				NT			NT				NT		
VINYL ACETATE	E	F	F	F	30	.08	67	E	E	G	G	30	.03	33	NT				NT			NT				NT		
XYLENES *(XYLOLS)*	E	G	F	P	92	.002	4	NT				23	—	133	NT				NT			NT				4	—	283

KEY TO DEGRADATION RATINGS:

Performance Rating	Weight Change
(E) Excellent	0 to 10%
(G) Good	11 to 20%
(F) Fair	21 to 30%
(P) Poor	Over 30%

KEY TO PERMEATION AND BREAKTHROUGH RATE:

BTT - Breakthrough time
LDL - Lower detection limit
PPM - Parts per million at breakthrough
MG - Milligrams per metre square per second

ND - None detected
> - Greater than < - Less than
NT - Not tested
- Rate too large to measure

HIGHLIGHTED CHEMICALS ARE EITHER KNOWN OR SUSPECTED CARCINOGENS

AR 305788

ATTACHMENT C

DRAFT

HEALTH AND SAFETY PROGRAM

FOR

HAZARDOUS WASTE OPERATIONS

SECTION VIII

HEALTH AND SAFETY PROCEDURE #1
HAZARD COMMUNICATION PROGRAM

Revisions	Date

Langan
Engineering and Environmental Services, Inc.

SECTION VIII
HEALTH AND SAFETY PROCEDURE #1
HAZARD COMMUNICATION PROGRAM

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8.0 PURPOSE

In November 1983, OSHA published the "Hazard Communication Standard", 29 CFR 1910.1200. The standard was developed to ensure that the hazards of all chemicals are evaluated and that information concerning the hazards is transmitted to employers and employees. In brief, the standard requires an evaluation of all chemicals and an implementation of a hazard communication program for all employees potentially exposed to hazardous chemicals. In August, 1987 OSHA revised the "Hazard Communication Standard" to expand the scope of the industries, covered by the rules, from the manufacturing sector to all industries where employees are potentially exposed to hazardous chemicals. The standard applies to any chemical present in the workplace in such a manner that employees may be exposed under normal conditions of use or in a foreseeable emergency. This procedure has been established to provide implementation of a comprehensive Hazard Communication Program.

8.1 Scope

This procedure applies to all Langan Engineering and Environmental Services, Inc. (Langan) site locations and activities, including office and field locations.

8.2 Definitions

The following definitions are referenced in the "Hazard Communication Standard".

Affected Employees - An employee who may be exposed to hazardous chemicals under normal working conditions or in a foreseeable emergency.

CAS Number - The identification number assigned by the Chemical Abstracts Service to a particular chemical substance.

Chemical - Any element, chemical compound or mixture of elements and/or chemical compounds.

Chemical family - Indicates the general class of compounds in which the hazardous substance is a member (i.e.; acids, ketones).

Chemical name - The scientific designation of a chemical in accordance with the nomenclature system developed by the International Union of Pure and Applied Chemistry (IUPAC) or the Chemical Abstract Service (CAS) rules of nomenclature, or a name which will clearly identify the chemical for the purpose of conducting a hazard evaluation.

Common name - Any designation or identification such as code name, code number, trade name, brand name or generic name used to identify a chemical other than by its chemical name.

Hazardous chemical - Any chemical which is a physical or health hazard.

8.3 Responsibilities

Health and Safety Manager (HSM) - This individual will be responsible for the implementation of the Hazard Communication Program and compliance with the OSHA Hazard Communication Standard, 29 CFR 1910.1200. These responsibilities include completing chemical inventory use audits, annually updating the chemical inventory list, assuring labeling of containers is adequate and maintained, obtaining and maintaining Material Safety Data Sheets (MSDSs), and notifying employees and contractors of the hazards associated with non-routine tasks.

8.4 Procedures

8.4.1 Introduction

This section defines the elements of the Langan Hazard Communication Program. These procedures shall be used to effectively communicate the OSHA requirements and potential chemical hazards to be encountered during Langan work activities, assure personnel access to information on chemical hazards, and familiarize them on procedures for the safe handling of hazards in the workplace.

8.4.2 Hazard Determination

Hazard determinations for chemicals are made by the suppliers and manufacturers of these chemicals.

work practices and personal protective equipment.

8.4.3 Chemical Inventory List

A chemical inventory of hazardous materials must be developed and maintained at each work site. A sample Chemical Inventory List is found in Appendix A.

8.4.4 Labels

8.4.4.1 Incoming Products

Containers arriving from chemical manufacturers and/or distributors shall be inspected by receiving personnel for the following:

1. Labels and warnings are appropriate, legible, in English, and prominently displayed on each container; and

2. The existing labels have not been removed or defaced.

8.4.4.2 Transfer Containers

When a hazardous chemical is transferred from its primary container to a new one, the transfer container must be adequately labeled with the chemical name and warning information.

8.4.5 Material Safety Data Sheets

Copies of MSDSs shall be kept for all chemicals being used at each work location. A master file of MSDSs shall be kept in the library. Field offices or field sites must maintain a copy of the Site Specific HASP which should contain copies of the MSDSs for the chemicals in use during the project. Each MSDS shall be in English and will contain the following information:

1. The identity of the hazardous chemical(s);

2. Appropriate hazard warnings; and

3. Name and address of the chemical manufacturer, importer or other responsible party.

8.4.6 Training

All Langan employees shall be trained regarding the requirements of OSHA Standard 29 CFR 1910.1200, characteristics and safe handling of hazardous chemicals in the workplace at the time of initial assignment, prior to assignment of non-routine tasks, and whenever a new hazard is introduced into the workplace environment.

The following information shall be provided in the training course:

1. Requirements of the OSHA Hazard Communication Standard;

2. Location and availability of the Langan Hazard Communication Program; and

3. The details of the Langan Hazard Communication Program which include:

   a. An explanation of the labeling system and how to read them;
   b. An explanation of the MSDSs and how to obtain and use them to find the appropriate hazard information;
   c. The location of toxic chemicals to which employees may be exposed;
   d. The name(s) of toxic substances present in the work area including generic, chemical, common, and trade names;
   e. The physical and chemical properties of toxic substances to which employees may be exposed;
   f. Definition of terms (e.g. exposure, TLV, PEL, etc.);
   g. Short and long term health effects of exposure to the hazardous materials;
   h. Symptoms of exposure;
   I. Methods and observations that may be used to detect the presence or release of a hazardous chemical in the workplace (such as monitoring conducted by the employer, continuous monitoring devices, visual appearance or odor of hazardous materials);
   j. Safe handling of hazardous materials;
   k. Emergency procedures to follow if exposed to hazardous materials; and
   l. How to lessen or prevent exposure to hazardous chemicals through safe work practices and personal protective equipment.

8.4.7 Non-Routine Tasks

In the event that an employee may be required to perform tasks which are not a part of his/her normal work routine, the employee will be given information about hazards involved with such activities. This information shall include:

1. Specific chemical hazards;
2. Protective measures the employee can take; and
3. Measures that Langan has taken to minimize the hazards including ventilation, respirators, presence of another employee, and emergency procedures.

8.4.8 Recordkeeping

The following records must be maintained:

1. A record of employee training program and attendance;
2. The Chemical Inventory List; and
3. MSDSs locations.

8.4.9 Informing Subcontractors

The following information will be available to each subcontractor (i.e.; drillers) as part of their initial contract:

1. Copy of the Langan Hazard Communication Program;
2. List of hazardous substances they may encounter while on the job; and
3. MSDS for each chemical on the list.

Each contractor shall be informed of:

1. Hazardous chemicals to which they may be exposed;
2. Measures the employees shall take to lessen the possibility of exposure;

3. Steps the company has taken to lessen the risks; and

4. First aid/emergency procedures.

Contractors shall be required to provide MSDSs for any chemicals brought onto a Langan work site and shall ensure that appropriate labels are on all containers. Langan employees will be informed of the potential hazards if there is a possibility that they will come into contact with such hazards.

Contractor will be responsible for his/her own Site Specific HASP along with the implementation of same.

8.5 References

29 CFR 1910.1200

8.6 Attachments

A. Chemical Inventory List

ATTACHMENT A
CHEMICAL INVENTORY LIST

The following is the Chemical Inventory List for this facility:

CHEMICAL NAME	MANUFACTURER	LOCATION/DEPT.

ATTACHMENT D

DRAFT

HEALTH AND SAFETY PROGRAM

FOR

HAZARDOUS WASTE OPERATIONS

SECTION IX

HEALTH AND SAFETY PROCEDURE #2
EMERGENCY RESPONSE PROCEDURES

Revisions	Date

Langan
Engineering and Environmental Services, Inc.

SECTION IX
HEALTH AND SAFETY PROCEDURE #2
EMERGENCY RESPONSE PROCEDURES

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9.0 PURPOSE

There are several requirements for emergency and/or contingency plans under OSHA and EPA. These requirements address plans for field operations. This procedure establishes the components of an effective emergency plan for field office locations. A site specific Emergency Response Plan should be included in the site specific Health and Safety Plan (HASP).

9.1 Scope

This procedure applies to Langan Engineering & Environmental Services, Inc. (Langan) field work locations. For work covered by 29 CFR 1910.120, the site-specific HASP will specify the emergency procedures for the site.

9.2 Definitions

None.

9.3 Responsibilities

Site Emergency Coordinator - The Site Emergency Coordinator shall implement emergency procedures whenever conditions warrant such action. The Site Emergency Coordinator will be responsible for assuring the evacuation, emergency treatment, emergency transport of site personnel, and notification of emergency response units.

Employees - All employees must be familiar with emergency response procedures for their work location(s).

9.4 Procedures

9.4.1 Emergency Plan

Emergency situations can be characterized as a fire or explosion, serious weather conditions, an environmental release, or accident or injury to personnel.

9.4.2 Evacuation

In the event of an emergency situation, all personnel will evacuate and assemble at a predesignated location identified in the Emergency Response Plan. The Emergency Coordinator will have authority to initiate action if outside services are required. No one will be allowed to proceed into the area once the emergency signal has been given. The Emergency Coordinator will ensure that access for emergency equipment is provided and that all combustion apparatus (eg. operating machinery) has been shut down once the alarm has been sounded.

9.4.3 Personnel Injury

In the case of a personnel injury, immediately initiate emergency first aid. If it is necessary to transport the field personnel to the nearest medical facility, they should be cleaned up or decontaminated en route. The HSC shall supply medical data sheets to medical personnel. The ambulance/ rescue squad may be contacted for transport if necessary. Some situations may require transport of an injured party by automobile; therefore, maps for the hospital route are to be provided for each work location as part of the Site Specific HASP. The HSC must complete an incident report on the accident or injury within 24 hours.

Personnel that require emergency or regular medical treatment must have a written release from the physician before being permitted to return to work.

9.4.4 Personnel Exposure

Emergency first aid procedures to be followed are outlined below.

SKIN CONTACT:	Use copious amounts of soap and water. Wash/rinse affected area thoroughly, then provide appropriate medical attention. Eyes should be thoroughly rinsed with water for at least 15 minutes.
INHALATION:	Move to fresh air and/or, if necessary decon/transport to hospital.
INGESTION:	Decontaminate and transport to emergency medical facility.
PUNCTURE WOUND/ LACERATION	Decontaminate, if possible and transport to emergency medical facility. HSC will provide medical data sheets to medical personnel as requested.

9.4.5 Fire Protection

Appropriate portable fire extinguishers will be available. Personnel who may be required to use them must be trained annually in the proper selection and use.

9.4.6 Chemicals Spills

Minor chemical spills may be cleaned up utilizing the appropriate absorbents. If the spill is major or very hazardous, only trained, qualified employees may respond.

9.4.7 Serious Weather Conditions

Procedures to monitor weather conditions will be implemented. If serious weather conditions (tornados, thunderstorms) develop all personnel will proceed to the predesignated shelters as designated in the Site Specific HASP.

9.4.8 Employee Training

Employees must be trained in emergency procedures applicable to their work location. This training must be documented.

9.5 References

29 CFR 1910 Subpart F
29 CFR 1910.120
29 CFR 1910.38

9.6 Attachments

Location Specific Information:

- Emergency Plan and Procedures
- Evacuation Routes/ Weather Shelters
- Alarm System
- Emergency Phone # and Contacts
- Emergency Equipment and PPE Available

ATTACHMENT E

ORIGINAL
(Red)

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HEALTH AND SAFETY PROGRAM

FOR

HAZARDOUS WASTE OPERATIONS

SECTION XV

HEALTH AND SAFETY PROCEDURE #8
HEAT STRESS CONTROL

Revisions	Date

Langan
Engineering and Environmental Services, Inc.

SECTION XV
HEALTH AND SAFETY PROCEDURE #8
HEAT STRESS CONTROL

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15.0 PURPOSE

Heat stress is recognized as one of the most common health effects caused by working in high heat conditions and especially when working in personal protective clothing. This procedures has been developed to establish guidelines for the implementation and operation of a heat stress prevention, evaluation, and response program.

15.1 Scope

This procedure applies to all Langan Engineering & Environmental Services, Inc. (Langan) activity where personnel may be exposed to environments exceeding 70 degrees Fahrenheit while performing Levels C and B work, and environments exceeding 80 degrees Fahrenheit while performing Level D work.

15.2 Definitions

Acclimation - Acclimation is the process of the body becoming accustomed to extremes in temperature.

ACGIH TLV - Heat Stress Threshold Limit Values (TLVs) are intended to protect workers from the severest effects of heat stress and heat injury and to describe exposures to hot working conditions under which it is believed that nearly all workers can be repeatedly exposed without adverse health effects. The TLV objective is to prevent the deep body core temperature from exceeding 38°C (100.4°F).

Wet-Bulb Globe Temperature (WBGT) - This is the simplest and most suitable technique to measure the environmental factors associated with heat stress. The value is calculated by using equations shown in Attachment A.

Work-Rest Regimen - This is a ratio of time spent working versus time spent resting. The ratio applies to one hour periods. For example, a work-rest regiment of 75% work, 25% rest corresponds to 45 minutes work, 15 minutes rest each hour.

15.3 Responsibilities

Site Personnel - All site personnel must be alert to symptoms of heat stress in themselves and in those working with them. Personnel must also be aware of the emergency corrective actions to be taken in response to the symptoms of heat stress..

Health and Safety Coordinator (HSC) - The HSC is responsible for establishing and enforcing the work-rest regimen to control heat stress.

15.4 Procedures

Acclimation to heat involves a series of physiological and psychological adjustments that occur in an individual during his/her first week of exposure to hot environmental conditions. The work - rest regimen in this procedure is valid for acclimated workers who are physically fit as determined through medical monitoring procedures.

15.4.1 Effects of Heat Stress

Hot weather can cause physical discomfort, loss of efficiency, and personal injury. Wearing personal protective equipment (PPE) puts a worker at a higher potential risk of developing heat stress since protective clothing decreases natural body ventilation. Regular monitoring and preventive measures are essential to the health and safety of personnel conducting field work.

Early symptoms of heat stress may include fatigue, irritability, anxiety, and decreased concentration, dexterity, or movement. If not recognized or treated, heat stress may become fatal.

Heat stress comes in different forms, which are listed below in order of increasing severity.

1. Heat Rash caused by continuous exposure to hot and humid air, and aggravation of the skin by chafing clothes. In addition to being a nuisance, this decreases the ability to tolerate heat.

2. Heat Cramps caused by profuse perspiration in conjunction with inadequate fluid intake and chemical replacement (especially salts). Signs of heat cramp include muscle spasms and pain in the extremities and abdomen.

3. Heat Exhaustion caused by stress on various organs to meet increased demands for body cooling. Signs include shallow breathing; pale, cool, moist skin; profuse sweating; dizziness; and/or fatigue.
4. Heat Stroke is the most severe form of heat stress. Heat stroke is considered an Immediately Dangerous to Life or Health (IDLH)

condition and as such must be treated as an emergency. Any person suffering from heat stroke must be cooled down immediately and brought to a hospital. Decontamination procedures should not be implemented. Signs of heat stroke include red, hot, dry skin; no perspiration; nausea; dizziness and confusion; strong, rapid pulse; and/or coma.

It is important to note that individuals vary in their susceptibility and their reactions to heat related conditions. Factors that may predispose someone to a heat condition include:

- Lack of physical fitness;
- Lack of acclimation;
- Age;
- Dehydration;
- Obesity;
- Alcohol and drug use;
- Infection;
- Sunburn;
- Diarrhea; and
- Chronic disease.

15.4.2 First-Aid / Medical Treatment

First-aid and medical treatments recommended as corrective actions for people suffering from different forms of heat stress are outlined below.

1. Heat Rash - Apply mild drying lotions and utilize cool, dry sleeping quarters to allow skin to dry between heat exposures.

2. Heat Cramps - Administer commercially-available electrolyte-balanced liquids. Seek medical attention if serious.

3. Heat Exhaustion - Remove to cooler environment, rest in reclining position. Drink plenty of fluids.

4. Heat Stroke - Immediate and rapid cooling by removing clothes and bathing limbs in lukewarm water and fanning. These steps are to be taken while waiting for emergency response to arrive, or while transporting the victim to an emergency medical facility. This is a **life-threatening** situation.

15.4.3 Heat Stress Prevention

The measures outlined below shall be followed to help prevent or reduce heat stress.

1. Drinking water shall be made available and all personnel shall be encouraged to take frequent small drinks, (i.e. one cup every 15-20 minutes, about 150 ml or 1/4 pint). The water shall be kept reasonably cool (55-60°F) and shall be placed outside the contaminated areas. Personnel shall also be encouraged to maintain well balanced diets. If personnel are unacclimated, a commercially available product such as Gatorade or Exceed may be used for electrolyte replacement.

2. Cooling devices may be used to aid natural body ventilation; however, these devices add weight and, therefore, their use should be balanced against worker efficiency.

3. Long cotton underwear should be worn. It acts as a wick to help absorb moisture and protect the skin from direct contact with heat-absorbing protective clothing.

4. Air conditioned shelter or shaded areas should be provided to protect personnel during rest periods.

5. Mobile showers and/or hose-down facilities should be provided to reduce body temperature and cool protective clothing.

6. Operations should be conducted in the early morning or evening.

7. A rotating shift schedule should be implemented.

8. Additional personnel should be added to work teams.

9. Work slowdowns shall be mandated.

10. Good hygienic standards must be maintained by frequent change of clothing and daily showering. Clothing should be permitted to dry during rest periods.

11. All personnel shall be instructed in hot weather procedures. The training program shall include, as a minimum, instruction in:

a. Proper cooling procedures and appropriate first-aid treatment;
b. Proper clothing practices;
c. Proper eating and drinking habits;
d. Recognition of impending heat exhaustion;
e. Recognition of signs and symptoms of impending heat stroke; and
f. Safe work practices.

15.4.4 Work-Rest Regimen

Â work-rest regimen will be established for field work where personnel may be exposed to environments exceeding 80 degrees Fahrenheit for Level D work, and environments exceeding 70 degrees Fahrenheit for Levels C and B work. The American Conference of Governmental Industrial Hygienists' TLV Heat Stress Threshold Limit Values shall be used as a guideline.

If any heat stress symptoms are identified by the site personnel, the HSC should be notified immediately and all work activity should cease until the situation is corrected.

15.4.5 Biological Monitoring

In order to evaluate the effectiveness of the work-rest regimen, employees shall monitor their heart rates.

Heart rate (HR) should be measured by taking the pulse for 30 seconds at the beginning of each rest period. The HR should not exceed 110 beats/ min. If the HR is higher, the next work period should be shortened by 33 percent, while the length of rest period stays the same. If the pulse rate is still greater than 110 beats/min. at the beginning of the next rest period, the following work cycle should again be shortened by 33 percent. The length of the initial work period will be determined by the HSC as discussed in Section 15.3.

15.5 References

ACGIH TLV Booklet, 1993-1994

15.6 Attachments

ATTACHMENT A	Permissible Heat Exposure Threshold Limit Values
ATTACHMENT B	Wet Bulb Globe Temperature Index
ATTACHMENT C	Manual Measurement of WBGT Factors

ATTACHMENT A
Permissible Heat Exposure Threshold Limit Values
(values are given in °F WBGT)

WORK LOAD

Work-Rest Regimen	Light	Moderate	Heavy
Continuous Work	86	80	77
75% Work - 25% Rest, Each Hour	87	82	78
50% Work - 50% Rest, Each Hour	89	85	82
25% Work - 75% Rest, Each Hour	90	88	86

ATTACHMENT B
Wet Bulb Globe Temperature Index

A baseline work-rest regimen is selected using the WBGT procedure. The period of work will be adjusted based on the biological monitoring outlined in Section 15.4.5. of

The WBGT in conjunction with the work load required to perform each task is used to determine work-rest regimen. **Light** work examples include such tasks as sitting or standing to control machines or performing light hand or arm work. **Moderate** work includes walking about in coated coveralls and respirators doing moderate lifting and pushing. **Heavy** work corresponds to pick and shovel-type work or the use of full body protective clothing. *It must be assumed that any activity involving this type of clothing will be considered heavy work.*

In order to determine the WBGT the following equations are used:

- Outdoors with solar load:
  WBGT = 0.7 WB + 0.2 GT + 0.1 DB

- Indoors or outdoors with no solar load:
  WBGT = 0.7 WB + 0.3 GT

  WB = Natural Wet-Bulb Temperature
  DB = Dry-Bulb Temperature
  GT = Globe Thermometer Temperature

The factors involved in the above equations can be measured using a direct reading instrument or manually measuring each factor.

- An example of a direct-reading heat stress monitor is the Reuter-Stokes Widget No. RSS-214 heat stress monitor.

- Assessment of individual factors requires the following equipment:

  - Dry-bulb thermometer
  - Natural wet-bulb thermometer
  - Globe thermometer
  - Stand

ATTACHMENT C
Manual Measurement of WBGT Factors

The range of the dry and the natural wet-bulb thermometers shall be -5°C to 50°C with an accuracy of 0.5° C. The dry-bulb thermometer must be shielded from the sun and the other radiant surfaces of the environment without restricting the airflow around the bulb. The wick of the natural wet-bulb thermometer shall be kept wet with distilled water for at least ½ hour before the temperature reading is made. It is not enough to immerse the other end of the wick into a reservoir of distilled water and wait until the whole wick becomes wet by capillary action. The wick shall be wetted by direct application of water from a syringe ½ hour before each reading. The wick shall extend over the bulb of the thermometer, covering the stem about one additional bulb length. The wick should always be clean and new wicks shall be washed before using.

A globe thermometer, consisting of a 15 cm (6-inch) diameter hollow copper sphere painted on the outside with a matted black finish, or equivalent, shall be used. The bulb or sensor of a thermometer (range -5°C to 100 C with an accuracy of 0.5 C) must be fixed in the center of the sphere. The globe thermometer shall be exposed at least 25 minutes before it is read.

A stand shall be used to suspend the three thermometers so that they do not restrict free airflow around the bulbs.

It is permissible to use any other type of temperature sensor that gives identical reading as that of a mercury thermometer under the same conditions.

The thermometers must be so placed that the readings are representative of the condition where the men work and rest, respectively. All readings shall be recorded on the site log.

In many cases WBGT is the simplest and most suitable technique to measure heat. However, this system is only valid for light summer clothing. When special personal protective clothing is required for performing a particular job the worker's heat tolerance is reduced and the permissible heat exposure limits are not applicable, since this clothing is heavier, impedes sweat evaporation and/or has higher insulation value.

ATTACHMENT F

ORIGINAL (Red)

HEALTH AND SAFETY PROGRAM

FOR

HAZARDOUS WASTE OPERATIONS

SECTION XVI

HEALTH AND SAFETY PROCEDURE #9
COLD STRESS CONTROL

Revisions	Date

Langan
Engineering and Environmental Services, Inc.

SECTION XVI
HEALTH AND SAFETY PROCEDURE #9
COLD STRESS CONTROL

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16.0 PURPOSE

One of the hazards of working outdoors during winter months is cold stress. This procedure was developed to establish guidelines for the implementation, operation, and monitoring of a cold stress prevention, evaluation, and response program in order to prevent cold related injuries or illnesses. The recognition of the signs and symptoms related to exposure to cold will necessitate prompt corrective action to prevent permanent injury or death.

16.1 Scope

This procedure applies to Langan Engineering & Environmental Services, Inc. (Langan) activities where personnel may be exposed to environments with an ambient temperature of 30 degrees fahrenheit or less.

16.2 Definitions

Acclimation - Acclimation is the process of the body becoming accustomed to extremes in temperature.

ACGIH TLV - Cold Stress Threshold Limit Values (TLVs) are intended to protect workers from the most severe effects of cold stress (hypothermia) and cold injury and to describe exposures to cold working conditions under which it is believed that nearly all workers can be repeatedly exposed without adverse health effects. The TLV objective is to prevent the deep body core temperature from falling below 36 degrees celsius (96.8 degrees fahrenheit) and to prevent cold injury to body extremities. For a single, occasional exposure to a cold environment a drop in core temperature no lower than 35 degrees celsius (95 degrees fahrenheit) should be permitted. In addition to provisions for total body protection, the TLV objective is to protect all parts of the body from cold injury, with emphasis on hands, feet, and head.

Equivalent Chill Temperature (ECT) - An index describing the effect of the cooling power of moving air on exposed flesh. The effect of wind velocity at a certain temperature is expressed as the equivalent cooling effect of a lower temperature with still air.

Frostbite - Local tissue damage caused by exposure to low temperatures. A severe occurrence may lead to deep tissue damage, gangrene or possible loss of affected areas.

Hypothermia - Lowering of the body core temperature due to exposure to cold. Severe hypothermia may result in death.

16.3 Responsibilities

Site Personnel - All site personnel shall be alert to the signs of cold stress in themselves and in those working with them. Personnel must also be aware of the emergency corrective actions to be taken in response to cold stress.

Health and Safety Coordinator (HSC) - The HSC is responsible for implementing the monitoring of cold stress conditions and enforcing the work-warming regimen to control cold stress.

16.4 Guidelines

16.4.1 Introduction

Ambient temperatures and wind velocity influence the development of a cold injury. Wind chill is used to describe the chilling effect of moving air in combination with low temperatures. Due to the effectiveness of water as a conductor of heat, the body cools suddenly when personal protective equipment (PPE) is removed if the clothing underneath is soaked with perspiration; therefore, precautions should be taken to remove PPE when the person is inside or not exposed to the elements.

16.4.2 Frostbite

Local injury resulting from the cold is called frostbite. Areas of the body, such as fingers, toes, and ears, are the most susceptible. Frostbite of the extremities can be categorized into degrees of damage. Frostbite comes in different forms, which are listed below in order of increasing severity.

1. Frost nip or incident frostbite is characterized by sudden whitening of the skin.

2. Superficial frostbite is characterized by skin waxy or white in appearance which is firm to the touch, but tissue beneath is resilient.

3. Deep frostbite is characterized by tissues which are cold, pale, and solid. This situation is extremely serious.

16.4.3 Hypothermia

There are degrees of hypothermia characterized as "moderate" and "severe." A victim of **moderate** hypothermia may exhibit the first seven signs listed in Section 15.4.2. **Severe** hypothermia is characterized by extreme skin coldness, loss of consciousness, faint pulse, and/or infrequent or apparently absent respiration. If not treated, death may result.

As a general rule, the onset of severe shivering should signal danger. Exposure to cold shall be immediately terminated for any severely shivering worker.

16.4.3.1 Signs of Hypothermia

The signs of hypothermia are as follows:

1. Severe shivering;
2. Abnormal behavior;
3. Slowing;
4. Stumbling;
5. Weakness;
6. Repeated falling;
7. Inability to walk;
8. Collapse;
9. Stupor; and
10. Unconsciousness.

16.4.4 Emergency Action

In the case of hypothermia the emergency actions outlined below shall be initiated.

1. Remove the victim from the environment.
2. Seek expert medical help immediately.
3. Keep handling to a minimum. Do not rub or massage the victim.
4. Prevent further heat loss by covering the victim lightly with blankets. Plastic may be used for further insulation. Do not cover the victim's face.
5. If the victim is still conscious administer hot drinks; encourage activity, such as walking while wrapped in a blanket. Do not administer any form

of sedative, tranquilizer or analgesic (pain reliever). These may facilitate further heat loss and convert moderate hypothermia into a severe case.

16.4.5 Work-Place Monitoring

Work-place monitoring shall be conducted as stated below.

1. Whenever the air temperature at a work place falls to 30 degrees fahrenheit.

2. The equivalent chill temperature shall be obtained from the TLV booklet. This information shall be recorded with the other data in the site log. The HSC shall have the discretion of determining the length of time spent working and resting.

16.4.6 Work-Warming Regimen

A work-warming regimen will be established by the utilizing the TLV booklet. The TLVs assume that all workers are properly clothed for periods of work at temperatures below freezing. If work is performed continuously at an ECT of 20°F or below, efforts will be made to have heated shelters available for use during breaks.

During breaks the outer layer of clothing should be removed and the remainder of the clothing loosened to allow sweat evaporation. Dehydration may increase the susceptibility of the worker to cold injury; therefore, warm sweet drinks and soups should be provided for caloric intake and fluid volume. The intake of coffee shall not be permitted due to its diuretic and circulatory effect.

For work practices at or below 10°F, the HSC has the discretion to determine if the measures outlined below should be implemented.

1. Personnel shall be under constant protective observation (buddy system or other direct supervision).

2. The work rate should not be so high as to cause sweating that will result in wet clothing; if heavy work must be done, all rest periods must be taken in heated shelters and the opportunity for changing into dry clothing shall be provided.

3. Provisions shall be made to make sure employees become accustomed to the required PPE, as well as to their working environment.

4. Working conditions, and weight and bulkiness of clothing shall be included in estimating the required work performance and weights to be lifted by the site personnel.

5. The work shall be arranged in such a way that sitting still or standing still for long periods of time is minimized. Unprotected metal seats shall not be used. Also, personnel shall be protected from drafts to the greatest extent possible.

6. Site personnel should be aware of the following cold weather procedures:

   a. Proper rewarming procedures and appropriate first-aid treatment;
   b. Proper clothing practices;
   c. Proper eating and drinking habits;
   d. Recognition of impending frostbite;
   e. Recognition of signs and symptoms of impending hypothermia or excessive cooling of the body even when shivering does not occur; and
   f. Safe work practices.

16.4.7 Special Medical Considerations

Employees shall be excluded from working in temperatures at 30°F or below if they are:

1. Suffering from diseases or taking medication which interferes with normal body temperature regulation or reduces tolerance to work in cold environments; or

2. Has been medically certified as unsuitable for such exposures.

The HSC shall document this for each worker during site training.

For exposed skin, continuous exposure will not be permitted when ECT of -25°F is anticipated.

At air temperatures of 36°F or less, any worker who becomes immersed in water or whose clothing becomes wet will immediately be provided a change of clothing and treated for hypothermia.

16.4.8 Personal Protective Equipment Requirements

Whole body protection must be provided as follows:

- Adequate insulating clothing should be used by workers if work is performed in air temperatures below 40°F;
- Older workers or workers with circulatory problems may require special precautionary protection against cold injury, such as the use of extra insulating clothing and/or a reduction in the duration of exposure periods;
- If the available clothing does not give adequate protection to prevent hypothermia or frostbite, work shall be modified or suspended until adequate clothing is made available or until weather conditions improve; and
- Workers handling evaporative liquid (gasoline, alcohol, or cleaning fluids) at air temperatures below 40°F shall take special precautions to avoid soaking of clothing or gloves because of the added danger of cold injury due to evaporative cooling.

Special protection of the hands, at the discretion of the HSC, may be required as follows:

- If fine work is to be performed with bare hands for more than 10-20 minutes in an environment below 60°F, special provisions shall be established for keeping the worker's hands warm (i.e. warm air jets, radiant heaters, and/or insulated tool handles); and
- If fine manual dexterity is not required, gloves shall be used at air temperatures below 60°F for sedentary work, 40°F for light work, or 20°F for moderate work.

16.5 References

ACGIH TLV Booklet, 1993-1994.

16.6 Attachments

ATTACHMENT A - TLV BOOKLET

ATTACHMENT G

DRAFT

HEALTH AND SAFETY PROGRAM

FOR

HAZARDOUS WASTE OPERATIONS

SECTION XVII

HEALTH AND SAFETY PROCEDURE #10
EXCAVATION/TRENCHING OPERATIONS

Revisions	Date

Langan
Engineering and Environmental Services, Inc.

SECTION 17
HEALTH AND SAFETY PROCEDURE #10
EXCAVATION/TRENCHING OPERATIONS

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17.0 PURPOSE

OSHA in Subpart P of 29 CFR 1926 establishes specific requirements for excavations. These requirements include a competent person be on site and specific shoring or sloping procedures. In order to establish safe operating procedures for excavation/trenching operations at Langan Engineering & Environmental Services, Inc. (Langan) work sites and to meet the OSHA requirements, this procedure has been developed.

17.1 Scope

This procedure applies to all activity where excavation or trenching operations take place.

17.2 Definitions

Excavation - Any manmade cavity or depression in the earth's surface, including its sides, walls, or faces, formed by earth removal and producing unsupported earth conditions by reasons of the excavation.

Competent Person - is defined by OSHA as an individual capable of identifying existing and predictable hazards in the surroundings, or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.

Trench - A narrow excavation made below the surface of the ground. In general, the depth is greater than the width, but the width of a trench is not greater than 15 feet.

17.3 Responsibilities

Site Personnel - All site personnel must follow these procedures in excavation and trenching operations.

Health and Safety Coordinator (HSC) - The HSC is responsible for overseeing these procedures are implemented at each work site.

Competent Person - The designated Competent Person is responsible for determining the appropriate protective measures and conducting daily evaluations.

17.4 Procedures

17.4.1 Hazards Associated With Excavation/Trenching

The principal hazards associated with excavation/trenching are:

- Suffocation, crushing or other injury from falling material;
- Damage/failure of installed underground services and consequent hazards;
- Tripping, slipping or falling; and
- Possibility of explosive, flammable, toxic or oxygen-deficient atmosphere in excavation.

17.4.2 Procedures Prior to Excavation

These procedures should be followed for all jobs involving excavations.

1. Underground utilities
   - Determine the presence and location of any underground chemical or utility pipes, electrical, telephone or instrument wire or cables.
   - Identify the location of underground services by stakes or markers.
   - De-energize or isolate underground services during excavation. If not possible, or location is not definite, method of excavation shall be established to minimize hazards by such means as:
     - Use of hand tools in area of underground services;
     - Insulating personnel and equipment from possible electrical contact; and

- Use tools or equipment that will reduce possibility of damage to underground services and hazard to worker.

2. Identify Excavation Area

   - Areas to be excavated shall be identified and segregated by means of barricades, ropes and/or signs to prevent access of unauthorized personnel and equipment. Suitable means shall be provided to make barriers visible at all times.

3. Surface Water

   - Provide means of diverting surface water from excavation.

4. Shoring/ Bracing

   - Shoring or bracing shall be designed by a competent person, as defined by OSHA.

5. Structural Ramps

   - Structural ramps that are used solely by employees as a means of access or egress from the excavation shall be designed by a competent person.

17.4.3 Procedures For Conducting The Excavation

1. Determine the need for shoring/ sloping. The type of soil will establish the need for shoring, slope of the excavation, support systems, and equipment to be used. The soil condition may change as the excavation proceeds. Appendices A, B, C, D, E, and F of the OSHA Excavation Regulation, 29 CFR 1926 Subpart P (Attachment 1) are to be used in defining shoring and sloping requirements.

2. For safe use of mobile industrial equipment in or near the excavation, the load carrying capacity of soil shall be established and suitable protection against collapse of soil provided by the use of mats, barricades, restricting the location of equipment, or shoring shall be used.

3. Excavated material (soil) shall be stored at a distance from the edge of the excavation, as determined by the competent person.

4. All trench (vertical sides) excavations greater than 4 feet in depth shall be shored.

5. Ladders or other means of access/egress to excavations shall be provided at a; 1) maximum spacing of 100 feet on the perimeter of open excavations; and 2) 25 feet for trench excavations greater than 4 feet in depth.

6. The excavation shall be inspected daily for changes in conditions. Look for the presence of ground water, change in soil condition, or effects of weather such as rain or freeze. A safe means of continuing the work shall be established based on changes in condition.

7. If the excavation is deemed a confined space, appropriate monitoring for gas, toxic, or flammable materials will be conducted to establish the need for respiratory equipment, ventilation or other measures required to continue the excavation safely.

8. Adequate means of dewatering the excavation shall be provided as required.

9. A signal person shall be provided to direct powered equipment if working in the excavation with other personnel.

10. Warning vests will be worn when employees are exposed to public vehicular traffic.

11. Employees shall stand away from vehicles being loaded or unloaded, and shall not be permitted underneath loads handled by lifting or dragging equipment.

12. Emergency rescue equipment, such as breathing apparatus, a safety harness and line, or a basket stretcher, shall be readily available if deemed necessary by the HSC.

13. Walkways or bridges with standard guardrails shall be provided where employees or equipment are required or permitted to cross over excavations.

17.4.4 Entering the Excavation

No Langan employee shall enter an excavation which fails to meet the requirements of Section 17.4.3.

17.5 References

OSHA Regulations 29 CFR 1926 Subpart P - Excavations

17.6 Attachments

29 CFR 1926 Subpart P, Appendices A, B, C, D, E, and F

that are intended or could reasonably be expected to be applied or transmitted to the system.

(b) ***Design of sloping and benching systems.*** The slopes and configurations of sloping and benching systems shall be selected and constructed by the employer or his designee and shall be in accordance with the requirements of paragraph (b)(1); or, in the alternative, paragraph (b)(2); or, in the alternative, paragraph (b)(3); or, in the alternative, paragraph (b)(4), as follows:

(1) *Option (1)—Allowable configurations and slopes.* (i) Excavations shall be sloped at an angle not steeper than one and one-half horizontal to one vertical (34 degrees measured from the horizontal), unless the employer uses one of the other options listed below.

(ii) Slopes specified in paragraph (b)(1)(i) of this section, shall be excavated to form configurations that are in accordance with the slopes shown for Type C soil in Appendix B to this subpart.

(2) *Option (2)—Determination of slopes and configurations using Appendices A and B.* Maximum allowable slopes, and allowable configurations for sloping and benching systems, shall be determined in accordance with the conditions and requirements set forth in appendices A and B to this subpart.

(3) *Option (3)—Designs using other tabulated data.* (i) Designs of sloping or benching systems shall be selected from and in accordance with tabulated data, such as tables and charts.

(ii) The tabulated data shall be in written form and shall include all of the following:

(A) Identification of the parameters that affect the selection of a sloping or benching system drawn from such data;

(B) Identification of the limits of use of the data, to include the magnitude and configuration of slopes determined to be safe;

(C) Explanatory information as may be necessary to aid the user in making a correct selection of a protective system from the data.

(iii) At least one copy of the tabulated data which identifies the registered professional engineer who approved the data, shall be maintained at the jobsite during construction of the protective system. After that time the data may be stored off the jobsite, but a copy of the data shall be made available to the Secretary upon request.

(4) *Option (4)—Design by a registered professional engineer.* (i) Sloping and benching systems not utilizing Option (1) or Option (2) or Option (3) under paragraph (b) of this section shall be approved by a registered professional engineer.

(ii) Designs shall be in written form and shall include at least the following:

(A) The magnitude of the slopes that were determined to be safe for the particular project;

(B) The configurations that were determined to be safe for the particular project; and

(C) The identity of the registered professional engineer approving the design.

(iii) At least one copy of the design shall be maintained at the jobsite while the slope is being constructed. After that time the design need not be at the jobsite, but a copy shall be made available to the Secretary upon request.

(c) ***Design of support systems, shield systems, and other protective systems.*** Designs of support systems, shield systems, and other protective systems shall be selected and constructed by the employer or his designee and shall be in accordance with the requirements of paragraph (c)(1); or, in the alternative, paragraph (c)(2); or, in the alternative, paragraph (c)(3); or, in the alternative, paragraph (c)(4) as follows:

(1) *Option (1)—Designs using appendices A, C and D.* Designs for timber shoring in trenches shall be determined in accordance with the conditions and requirements set forth in appendices A and C to this subpart. Designs for aluminum hydraulic shoring shall be in accordance with paragraph (c)(2) of this section, but if manufacturer's tabulated data cannot be utilized, designs shall be in accordance with appendix D.

(2) *Option (2)—Designs Using Manufacturer's Tabulated Data.* (i) Design of support systems, shield systems, or other protective systems that are drawn from manufacturer's tabulated data shall be in accordance with all specifications, recommendations, and limitations issued or made by the manufacturer.

(ii) Deviation from the specifications, recommendations, and limitations issued or made by the manufacturer shall only be allowed after the manufacturer issues specific written approval.

(iii) Manufacturer's specifications, recommendations, and limitations, and manufacturer's approval to deviate from the specifications, recommendations, and limitations shall be in written form at the jobsite during construction of the protective system. After that time this data may be stored off the jobsite, but a copy shall be made available to the Secretary upon request.

(3) *Option (3)—Designs using other tabulated data.* (i) Designs of support systems, shield systems, or other protective systems shall be selected from and be in accordance with tabulated data, such as tables and charts.

(ii) The tabulated data shall be in written form and include all of the following:

(A) Identification of the parameters that affect the selection of a protective system drawn from such data;

(B) Identification of the limits of use of the data;

(C) Explanatory information as may be necessary to aid the user in making a correct selection of a protective system from the data.

(iii) At least one copy of the tabulated data, which identifies the registered professional engineer who approved the data, shall be maintained at the jobsite during construction of the protective system. After that time the data may be stored off the jobsite, but a copy of the data shall be made available to the Secretary upon request.

(4) *Option (4)—Design by a registered professional engineer.* (i) Support systems, shield systems, and other protective systems not utilizing Option 1, Option 2 or Option 3, above, shall be approved by a registered professional engineer.

(ii) Designs shall be in written form and shall include the following:

(A) A plan indicating the sizes, types, and configurations of the materials to be used in the protective system; and

(B) The identify of the registered professional engineer approving the design.

(iii) At least one copy of the design shall be maintained at the jobsite during construction of the protective system. After that time, the design may be stored off the jobsite, but a copy of the design shall be made available to the Secretary upon request.

(d) ***Materials and equipment.*** (1) Materials and equipment used for protective systems shall be free from damage or defects that might impair their proper function.

(2) Manufactured materials and equipment used for protective systems shall be used and maintained in a manner that is consistent with the recommendations of the manufacturer, and in a manner that will prevent employee exposure to hazards.

(3) When material or equipment that is used for protective systems is damaged, a competent person shall examine the material or equipment and evaluate its suitability for continued use. If the competent person cannot assure the material or equipment is able to support the intended loads or is otherwise suitable for safe use, then such material or equipment shall be removed from service, and shall be evaluated and approved by a registered professional engineer before being returned to service.

(e) ***Installation and removal of support.*** (1) *General.* (i) Members of support systems shall be securely connected together to prevent sliding, falling, kickouts, or other predictable failure.

(ii) Support systems shall be installed and removed in a manner that protects employees from cave-ins, structural collapses, or from being struck by members of the support system.

(iii) Individual members of support systems shall not be subjected to loads exceeding those which those members were designed to withstand.

(iv) Before temporary removal of individual members begins, additional precautions shall be taken to ensure the safety of employees, such as installing other structural members to carry the loads imposed on the support system.

(v) Removal shall begin at, and progress from, the bottom of the excavation. Members shall be released slowly so as to note any indication of possible failure of the remaining members of the structure or possible cave-in of the sides of the excavation.

(vi) Backfilling shall progress together with the removal of support systems from excavations.

(2) *Additional requirements for support systems for trench excavations.* (i) Excavation of material to a level no greater than 2 feet (.61 m) below the bottom of the members of a support system shall be permitted, but only if the system is designed to resist the forces calculated for the full depth of the trench, and there are no indications while the trench is open of a possible loss of soil from behind or below the bottom of the support system.

(ii) Installation of a support system shall be closely coordinated with the excavation of trenches.

(f) *Sloping and benching systems.* Employees shall not be permitted to work on the faces of sloped or benched excavations at levels above other employees except when employees at the lower levels are adequately protected from the hazard of falling, rolling, or sliding material or equipment.

(g) *Shield systems.* (1) *General.* (i) Shield systems shall not be subjected to loads exceeding those which the system was designed to withstand.

(ii) Shields shall be installed in a manner to restrict lateral or other hazardous movement of the shield in the event of the application of sudden lateral loads.

(iii) Employees shall be protected from the hazard of cave-ins when entering or exiting the areas protected by shields.

(iv) Employees shall not be allowed in shields when shields are being installed, removed, or moved vertically.

(2) *Additional requirement for shield systems used in trench excavations.* Excavations of earth material to a level not greater than 2 feet (.61 m) below the bottom of a shield shall be permitted, but only if the shield is designed to resist the forces calculated for the full depth of the trench, and there are no indications while the trench is open of a possible loss of soil from behind or below the bottom of the shield.

Appendix A to § 1926 Subpart P—Soil Classification

(a) *Scope and application*—(1) *Scope.* This appendix describes a method of classifying soil and rock deposits based on site and environmental conditions, and on the structure and composition of the earth deposits. The appendix contains definitions, sets forth requirements, and describes acceptable visual and manual tests for use in classifying soils.

(2) *Application.* This appendix applies when a sloping or benching system is designed in accordance with the requirements set forth in § 1926.652(b)(2) as a method of protection for employees from cave-ins. This appendix also applies when timber shoring for excavations is designed as a method of protection from cave-ins in accordance with appendix C to subpart P of part 1926, and when aluminum hydraulic shoring is designed in accordance with appendix D. This Appendix also applies if other protective systems are designed and selected for use from data prepared in accordance with the requirements set forth in § 1926.652(c), and the use of the data is predicated on the use of the soil classification system set forth in this appendix.

(b) *Definitions.* The definitions and examples given below are based on, in whole or in part, the following: American Society for Testing Materials (ASTM) Standards D653-85 and D2488; The Unified Soils Classification System, The U.S. Department of Agriculture (USDA) Textural Classification Scheme; and The National Bureau of Standards Report BSS-121.

Cemented soil means a soil in which the particles are held together by a chemical agent, such as calcium carbonate, such that a hand-size sample cannot be crushed into powder or individual soil particles by finger pressure.

Cohesive soil means clay (fine grained soil), or soil with a high clay content, which has cohesive strength. Cohesive soil does not crumble, can be excavated with vertical sideslopes, and is plastic when moist. Cohesive soil is hard to break up when dry, and exhibits significant cohesion when submerged. Cohesive soils include clayey silt, sandy clay, silty clay, clay and organic clay.

Dry soil means soil that does not exhibit visible signs of moisture content.

Fissured means a soil material that has a tendency to break along definite planes of fracture with little resistance, or a material that exhibits open cracks, such as tension cracks, in an exposed surface.

Granular soil means gravel, sand, or silt, (coarse grained soil) with little or no clay content. Granular soil has no cohesive strength. Some moist granular soils exhibit apparent cohesion. Granular soil cannot be molded when moist and crumbles easily when dry.

Layered system means two or more distinctly different soil or rock types arranged in layers. Micaceous seams or weakened planes in rock or shale are considered layered.

Moist soil means a condition in which a soil looks and feels damp. Moist cohesive soil can easily be shaped into a ball and rolled into small diameter threads before crumbling. Moist granular soil that contains some cohesive material will exhibit signs of cohesion between particles.

Plastic means a property of a soil which allows the soil to be deformed or molded without cracking, or appreciable volume change.

Saturated soil means a soil in which the voids are filled with water. Saturation does not require flow. Saturation, or near saturation, is necessary for the proper use of instruments such as a pocket penetrometer or sheer vane.

Soil classification system means, for the purpose of this subpart, a method of categorizing soil and rock deposits in a hierarchy of Stable Rock, Type A, Type B, and Type C, in decreasing order of stability. The categories are determined based on an analysis of the properties and performance characteristics of the deposits and the environmental conditions of exposure.

Stable rock means natural solid mineral matter that can be excavated with vertical sides and remain intact while exposed.

Submerged soil means soil which is underwater or is free seeping.

Type A means cohesive soils with an unconfined compressive strength of 1.5 ton per square foot (tsf) (144 KPa) or greater. Examples of cohesive soils are: clay, silty clay, sandy clay, clay loam and, in some cases, silty clay loam and sandy clay loam. Cemented soils such as caliche and hardpan are also considered Type A. However, no soil is Type A if:

(i) The soil is fissured; or

(ii) The soil is subject to vibration from heavy traffic, pile driving, or similar effects; or

(iii) The soil has been previously disturbed; or

(iv) The soil is part of a sloped, layered system where the layers dip into the excavation on a slope of four horizontal to one vertical (4H:1V) or greater; or

(v) The material is subject to other factors that would require it to be classified as a less stable material.

Type B means:

(i) Cohesive soil with an unconfined compressive strength greater than 0.5 tsf (48 kPa) but less than 1.5 tsf (144 kPa); or

(ii) Granular cohesionless soils including: angular gravel (similar to crushed rock), silt, silt loam, sandy loam and, in some cases, silty clay loam and sandy clay loam.

(iii) Previously disturbed soils except those which would otherwise be classed as Type C soil.

(iv) Soil that meets the unconfined compressive strength or cementation requirements for Type A, but is fissured or subject to vibration; or

(v) Dry rock that is not stable; or

(vi) Material that is part of a sloped, layered system where the layers dip into the excavation on a slope less steep than four horizontal to one vertical (4H:1V), but only if the material would otherwise be classified as Type B.

Type C means:

(i) Cohesive soil with an unconfined compressive strength of 0.5 tsf (48 kPa) or less; or

(ii) Granular soils including gravel, sand, and loamy sand; or

(iii) Submerged soil or soil from which water is freely seeping; or

(iv) Submerged rock that is not stable, or

(v) Material in a sloped, layered system where the layers dip into the excavation or a slope of four horizontal to one vertical (4H:1V) or steeper.

Unconfined compressive strength means the load per unit area at which a soil will fail in compression. It can be determined by laboratory testing, or estimated in the field using a pocket penetrometer, by thumb penetration tests, and other methods.

Wet soil means soil that contains significantly more moisture than moist soil, but in such a range of values that cohesive material will slump or begin to flow when vibrated. Granular material that would exhibit conesive properties when moist will lose those cohesive properties when wet.

(c) *Requirements*—(1) *Classification of soil and rock deposits.* Each soil and rock deposit shall be classified by a competent person as Stable Rock, Type A, Type B, or Type C in accordance with the definitions set forth in paragraph (b) of this appendix.

(2) *Basis of classification.* The classification of the deposits shall be made based on the results of at least one visual and at least one manual analysis. Such analyses shall be conducted by a competent person using tests described in paragraph (d) below, or in other recognized methods of soil classification and testing such as those adopted by the American Society for Testing Materials, or the U.S. Department of Agriculture textural classification system.

(3) *Visual and manual analyses.* The visual and manual analyses, such as those noted as being acceptable in paragraph (d) of this appendix, shall be designed and conducted to provide sufficient quantitative and qualitative information as may be necessary to identify properly the properties, factors, and conditions affecting the classification of the deposits.

(4) *Layered systems.* In a layered system, the system shall be classified in accordance with its weakest layer. However, each layer may be classified individually where a more stable layer lies under a less stable layer.

(5) *Reclassification.* If, after classifying a deposit, the properties, factors, or conditions affecting its classification change in any way, the changes shall be evaluated by a competent person. The deposit shall be reclassified as necessary to reflect the changed circumstances.

(d) *Acceptable visual and manual tests.*—(1) *Visual tests.* Visual analysis is conducted to determine qualitative information regarding the excavation site in general, the soil adjacent to the excavation, the soil forming the sides of the open excavation, and the soil taken as samples from excavated material.

(i) Observe samples of soil that are excavated and soil in the sides of the excavation. Estimate the range of particle sizes and the relative amounts of the particle sizes. Soil that is primarily composed of fine-grained material is cohesive material. Soil composed primarily of coarse-grained sand or gravel is granular material.

(ii) Observe soil as it is excavated. Soil that remains in clumps when excavated is cohesive. Soil that breaks up easily and does not stay in clumps is granular.

(iii) Observe the side of the opened excavation and the surface area adjacent to the excavation. Crack-like openings such as tension cracks could indicate fissured material. If chunks of soil spall off a vertical side, the soil could be fissured. Small spalls are evidence of moving ground and are indications of potentially hazardous situations.

(iv) Observe the area adjacent to the excavation and the excavation itself for evidence of existing utility and other underground structures, and to identify previously disturbed soil.

(v) Observe the opened side of the excavation to identify layered systems. Examine layered systems to identify if the layers slope toward the excavation. Estimate the degree of slope of the layers.

(vi) Observe the area adjacent to the excavation and the sides of the opened excavation for evidence of surface water, water seeping from the sides of the excavation, or the location of the level of the water table.

(vii) Observe the area adjacent to the excavation and the area within the excavation for sources of vibration that may affect the stability of the excavation face.

(2) *Manual tests.* Manual analysis of soil samples is conducted to determine quantitative as well as qualitative properties of soil and to provide more information in order to classify soil properly.

(i) *Plasticity.* Mold a moist or wet sample of soil into a ball and attempt to roll it into threads as thin as 1/8-inch in diameter. Cohesive material can be successfully rolled into threads without crumbling. For example, if at least a two inch (50 mm) length of 1/8-inch thread can be held on one end without tearing, the soil is cohesive.

(ii) *Dry strength.* If the soil is dry and crumbles on its own or with moderate pressure into individual grains or fine powder, it is granular (any combination of gravel, sand, or silt). If the soil is dry and falls into clumps which break up into smaller clumps, but the smaller clumps can only be broken up with difficulty, it may be clay in any combination with gravel, sand or silt. If the dry soil breaks into clumps which do not break up into small clumps and which can only be broken with difficulty, and there is no visual indication the soil is fissured, the soil may be considered unfissured.

(iii) *Thumb penetration.* The thumb penetration test can be used to estimate the unconfined compressive strength of cohesive soils. (This test is based on the thumb penetration test described in American Society for Testing and Materials (ASTM) Standard designation D2488—"Standard Recommended Practice for Description of Soils (Visual—Manual Procedure).") Type A soils with an unconfined compressive strength of 1.5 tsf can be readily indented by the thumb; however, they can be penetrated by the thumb only with very great effort. Type C soils with an unconfined compressive strength of 0.5 tsf can be easily penetrated several inches by the thumb, and can be molded by light finger pressure. This test should be conducted on an undisturbed soil sample, such as a large clump of spoil, as soon as practicable after excavation to keep to a minimum the effects of exposure to drying influences. If the excavation is later exposed to wetting influences (rain, flooding), the classification of the soil must be changed accordingly.

(iv) *Other strength tests.* Estimates of unconfined compressive strength of soils can also be obtained by use of a pocket penetrometer or by using a hand-operated shearvane.

(v) *Drying test.* The basic purpose of the drying test is to differentiate between cohesive material with fissures, unfissured cohesive material, and granular material. The procedure for the drying test involves drying a sample of soil that is approximately one inch thick (2.54 cm) and six inches (15.24 cm) in diameter until it is thoroughly dry:

(A) If the sample develops cracks as it dries, significant fissures are indicated.

(B) Samples that dry without cracking are to be broken by hand. If considerable force is necessary to break a sample, the soil has significant cohesive material content. The soil can be classified as an unfissured cohesive material and the unconfined compressive strength should be determined.

(C) If a sample breaks easily by hand, it is either a fissured cohesive material or a granular material. To distinguish between the two, pulverize the dried clumps of the sample by hand or by stepping on them. If the clumps do not pulverize easily, the material is cohesive with fissures. If they pulverize easily into very small fragments, the material is granular.

Appendix B to § 1926 Subpart P—Sloping and Benching

(a) *Scope and application.* This appendix contains specifications for sloping and benching when used as methods of protecting employees working in excavations from cave-ins. The requirements of this appendix apply when the design of sloping and benching protective systems is to be performed in accordance with the requirements set forth in § 1926.652(b)(2).

(b) *Definitions.*

Actual slope means the slope to which an excavation face is excavated.

Distress means that the soil is in a condition where a cave-in is imminent or is likely to occur. Distress is evidenced by such phenomena as the development of fissures in the face of or adjacent to an open excavation; the subsidence of the edge of an excavation; the slumping of material from the face or the bulging or heaving of material from the bottom of an excavation; the spalling of material from the face of an excavation; and ravelling, i.e., small amounts of material such as pebbles or little clumps of material suddenly separating from the face of an excavation and trickling or rolling down into the excavation.

Maximum allowable slope means the steepest incline of an excavation face that is acceptable for the most favorable site conditions as protection against cave-ins, and is expressed as the ratio of horizontal distance to vertical rise (H:V).

Short term exposure means a period of time less than or equal to 24 hours that an excavation is open.

(c) *Requirements*—(1) *Soil classification.* Soil and rock deposits shall be classified in accordance with appendix A to subpart P of part 1926.

(2) *Maximum allowable slope.* The maximum allowable slope for a soil or rock deposit shall be determined from Table B-1 of this appendix.

(3) *Actual slope.* (i) The actual slope shall not be steeper than the maximum allowable slope.

(ii) The actual slope shall be less steep than the maximum allowable slope, when there are signs of distress. If that situation occurs, the slope shall be cut back to an actual slope which is at least 1/2 horizontal to one vertical (1/2H:1V) less steep than the maximum allowable slope.

(iii) When surcharge loads from stored material or equipment, operating equipment, or traffic are present, a competent person shall determine the degree to which the actual slope must be reduced below the maximum allowable slope, and shall assure that such reduction is achieved. Surcharge loads from adjacent structures shall be evaluated in accordance with § 1926.651(i).

(4) *Configurations.* Configurations of sloping and benching systems shall be in accordance with Figure B-1.

TABLE B-1

MAXIMUM ALLOWABLE SLOPES

Soil or Rock Type	*Maximum Allowable Slopes (H:V)* [1] *For Excavations Less Than 20 Feet Deep* [3]
Stable Rock	Vertical (90°)
Type A [2]	3/4:1 (53°)
Type B	1:1 (45°)
Type C	1 1/2:1 (34°)

NOTES:

[1] Numbers shown in parentheses next to maximum allowable slopes are angles expressed in degrees from the horizontal. Angles have been rounded off.

[2] A short-term maximum allowable slope of 1/2 H:1V (63°) is allowed in excavations in Type A soil that are 12 feed (3.67 m) or less in depth. Short-term maximum allowable slopes for excavations greater than 12 feet (3.67 m) in depth shall be 3/4 H:1V (53°).

[3] Sloping or benching for excavations greater than 20 feet deep shall be designed by a registered professional engineer.

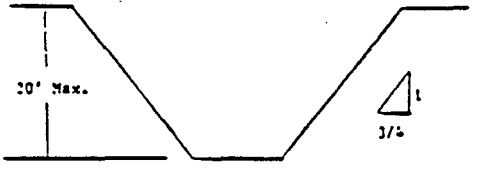
Figure B-1

Slope Configurations

(All slopes stated below are in the horizontal to vertical ratio)

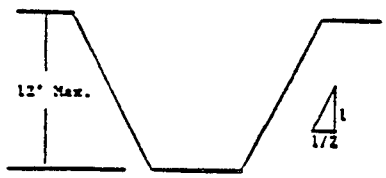
B-1.1 Excavations made in Type A soil.

1. All simple slope excavation 20 feet or less in depth shall have a maximum allowable slope of ¾:1.



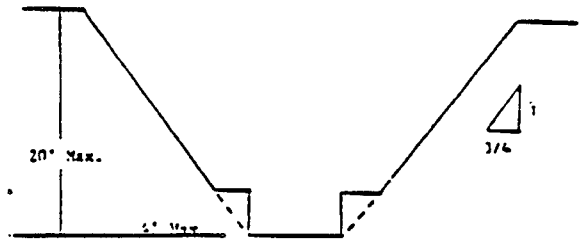
Simple Slope—General

Exception: Simple slope excavations which are open 24 hours or less (short term) and which are 12 feet or less in depth shall have a maximum allowable slope of 1/2:1.

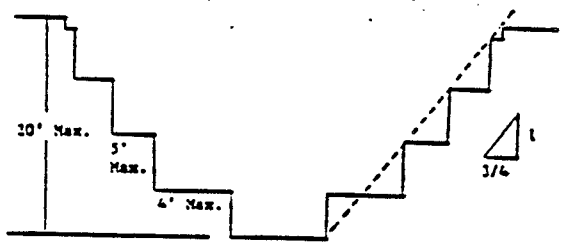


Simple Slope—Short Term

2. All bonched excavations 20 feet or less in depth shall have a maximum allowable slope of ¾ to 1 and maximum bench dimensions as follows:

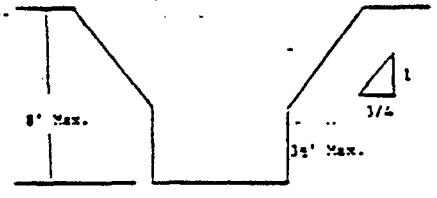


Simple Bench



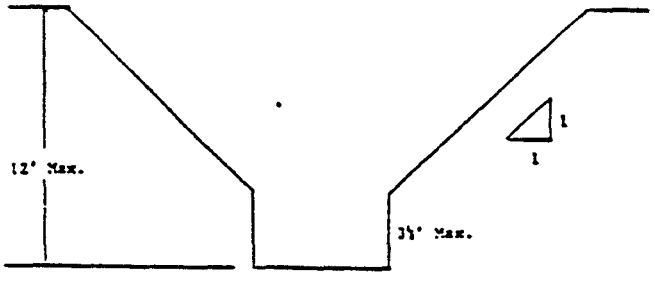
Multiple Bench

1. All excavations 6 feet or less in depth which have unsupported vertically sided lower portions shall have a maximum vertical side of 3½ feet.



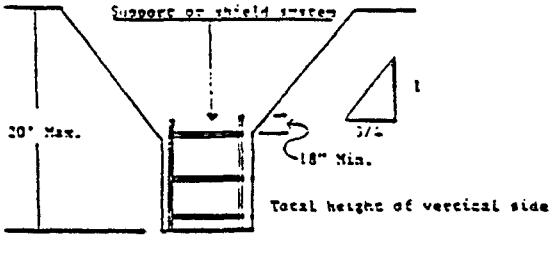
Unsupported Vertically Sided Lower Portion—Maximum 6 Feet in Depth

All excavations more than 6 feet but not more than 12 feet in depth which unsupported vertically sided lower portions shall have a maximum allowable slope of 1:1 and a maximum vertical side of 3½ feet.



Unsupported Vertically Sided Lower Portion—Maximum 12 Feet in Depth

All excavations 20 feet or less in depth which have vertically sided lower portions that are supported or shielded shall have a maximum allowable slope of ¾:1. The support or shield system must extend at least 18 inches above the top of the vertical side.

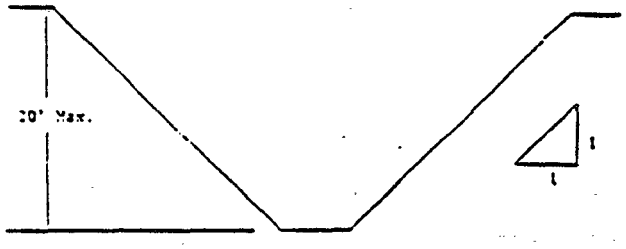


Supported or Shielded Vertically Sided Lower Portion

4. All other simple slope, compound slope, and vertically sided lower portion excavations shall be in accordance with the other options permitted under § 1926.652(b).

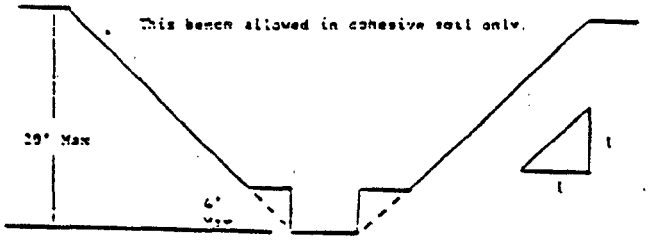
B–1.2 Excavations Made in Type B Soil

1. All simple slope excavations 20 feet or less in depth shall have a maximum allowable slope of 1:1.

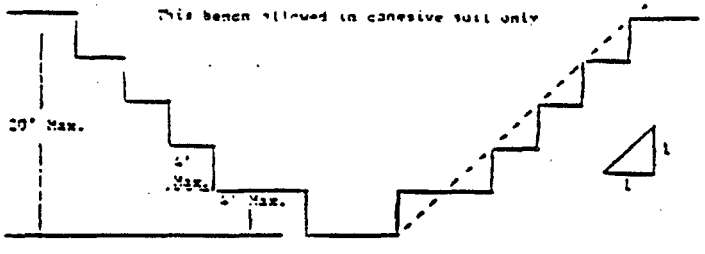


Simple Slope

2. All benched excavations 20 feet or less in depth shall have a maximum allowable slope of 1:1 and maximum bench dimensions as follows:

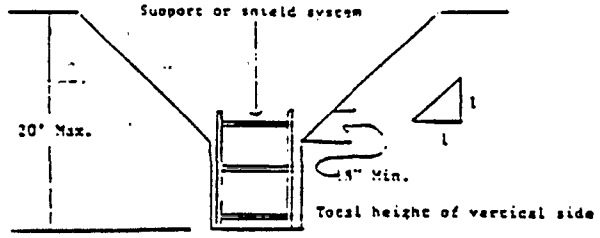


Simple Bench



Multiple Bench

3. All excavations 20 feet or less in depth which have vertically sided lower portions shall be sheeted or supported to a height at least 18 inches above the top of the vertical side. All such excavations shall have a maximum allowable slope of 1:1.

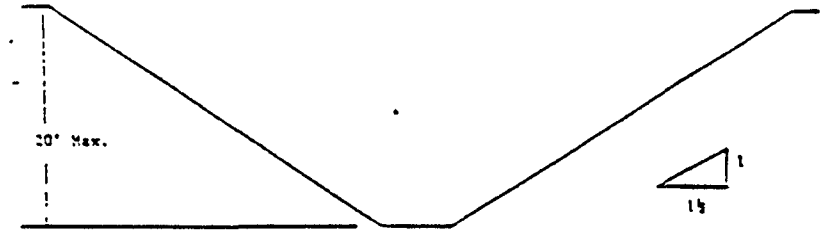


Vertically Sided Lower Portion

4. All other sloped excavations shall be in accordance with the other options permitted in § 1926.652(b).

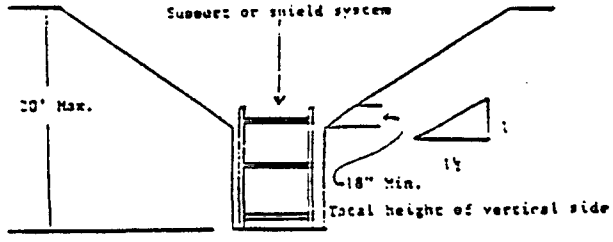
B-1.3 Excavations Made in Type C Soil

1. All simple slope excavations 20 feet or less in depth shall have a maximum allowable slope of 1½:1.



Simple Slope

2. All excavations 20 feet or less in depth which have vertically sided lower portions shall be sheeted or supported to a height at least 18 inches above the top of the vertical side. All such excavations shall have a maximum allowable slope of 1½:1.

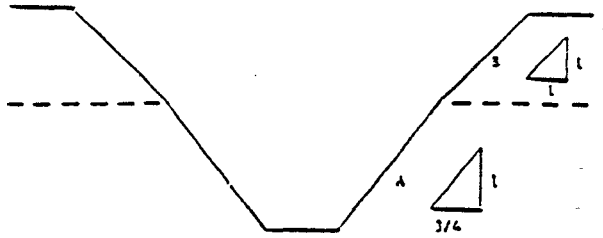


Vertical Sided Lower Portion

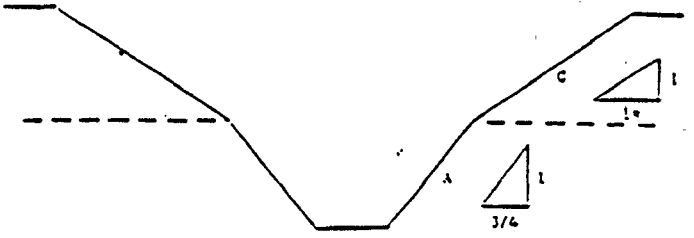
2. All other slopes excavations shall be in accordance with the other options permitted in § 1926.652(b).

B-1.4 Excavations Made in Layered Soils

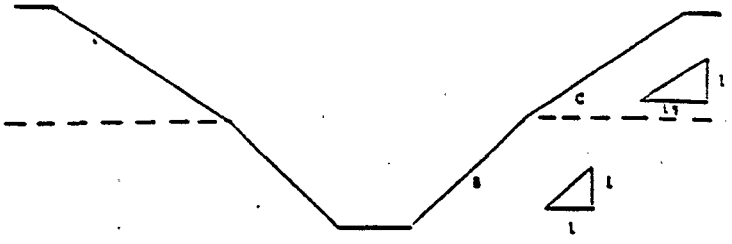
1. All excavations 20 feet or less in depth made in layered soils shall have a maximum allowable slope for each layer as set forth below.



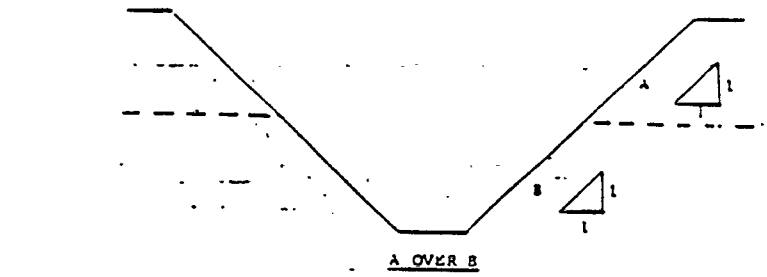
B OVER A



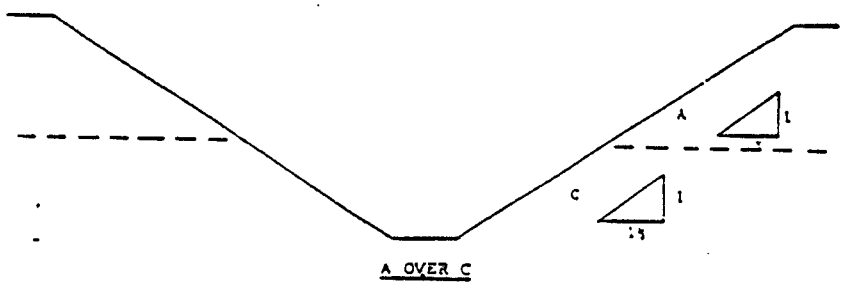
C OVER A



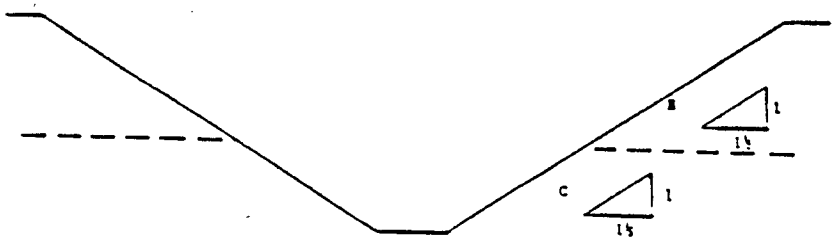
C OVER B



A OVER B



A OVER C



B OVER C

2. All other sloped excavations shall be in accordance with the other options permitted in § 1926.652(b).

Appendix C to § 1926 Subpart P—Timber Shoring For Trenches

(a) *Scope.* This appendix contains information that can be used when timber shoring is provided as a method of protection from cave-ins in trenches that do not exceed 20 feet (6.1 m) in depth. This appendix must be used when design of timber shoring protective systems is to be performed in accordance with § 1926.652(c)(1). Other timber shoring configurations: other systems of support such as hydraulic and pneumatic systems; and other protective systems such as sloping, benching, shielding, and freezing systems must be designed in accordance with the requirements set forth in § 1926.652(b) and § 1926.652(c).

(b) *Soil Classification.* In order to use the data presented in this appendix, the soil type or types in which the excavation is made must first be determined using the soil classification method set forth in appendix A of subpart P of this part.

(c) *Presentation of Information.* Information is presented in several forms as follows:

(1) Information is presented in tabular form in Tables C-1.1, C-1.2 and C-1.3, and Tables C-2.1, C-2.2 and C-2.3 following paragraph (g) of the appendix. Each table presents the minimum sizes of timber members to use in a shoring system, and each table contains data only for the particular soil type in which the excavation or portion of the excavation is made. The data are arranged to allow the user the flexibility to select from among several acceptable configurations of members based on varying the horizontal spacing of the crossbraces. Stable rock is exempt from shoring requirements and therefore, no data are presented for this condition.

(2) Information concerning the basis of the tabular data and the limitations of the data is presented in paragraph (d) of this appendix, and on the tables themselves.

(3) Information explaining the use of the tabular data is presented in paragraph (e) of this appendix.

(4) Information illustrating the use of the tabular data is presented in paragraph (f) of this appendix.

(5) Miscellaneous notations regarding Tables C-1.1 through C-1.3 and Tables C-2.1 through C-2.3 are presented in paragraph (g) of this Appendix.

(d) *Basis and limitations of the data.*—(1) *Dimensions of timber members.* (i) The sizes of the timber members listed in Tables C-1.1 through C-1.3 are taken from the National Bureau of Standards (NBS) report, "Recommended Technical Provisions for Construction Practice in Shoring and Sloping of Trenches and Excavations." In addition, where NBS did not recommend specific sizes of members, member sizes are based on an analysis of the sizes required for use by existing codes and on empirical practice.

(ii) The required dimensions of the members listed in Tables C-1.1 through C-1.3 refer to actual dimensions and not nominal dimensions of the timber. Employers wanting to use nominal size shoring are directed to Tables C-2.1 through C-2.3, or have this choice under § 1926.652(c)(3), and are referred to The Corps of engineers, The Bureau of Reclamation or data from other acceptable sources.

(2) *Limitation of application.* (i) It is not intended that the timber shoring specification apply to every situation that may be experienced in the field. These data were developed to apply to the situations that are most commonly experienced in current trenching practice. Shoring systems for use in situations that are not covered by the data in this appendix must be designed as specified in § 1926.652(c).

(ii) When any of the following conditions are present, the members specified in the tables are not considered adequate. Either an alternate timber shoring system must be designed or another type of protective system designed in accordance with § 1926.652.

(A) When loads imposed by structures or by stored material adjacent to the trench weigh in excess of the load imposed by a two-foot soil surcharge. The term "adjacent" as used here means the area within a horizontal distance from the edge of the trench equal to the depth of the trench.

(B) When vertical loads imposed on cross braces exceed a 240-pound gravity load distributed on a one-foot section of the center of the crossbrace.

(C) When surcharge loads are present from equipment weighing in excess of 20,000 pounds.

(D) When only the lower portion of a trench is shored and the remaining portion of the trench is sloped or benched unless: The sloped portion is sloped at an angle less steep than three horizontal to one vertical; or the members are selected from the tables for use at a depth which is determined from the top of the overall trench, and not from the toe of the sloped portion.

(e) *Use of Tables.* The members of the shoring system that are to be selected using this information are the cross braces, the uprights, and the wales, where wales are required. Minimum sizes of members are specified for use in different types of soil. There are six tables of information, two for each soil type. The soil type must first be determined in accordance with the soil classification system described in appendix A to subpart P of part 1926. Using the appropriate table, the selection of the size and spacing of the members is then made. The selection is based on the depth and width of the trench where the members are to be installed and, in most instances, the selection is also based on the horizontal spacing of the crossbraces. Instances where a choice of horizontal spacing of crossbracing is available, the horizontal spacing of the crossbraces must be chosen by the user before the size of any member can be determined. When the soil type, the width and depth of the trench, and the horizontal spacing of the crossbraces are known, the size and vertical spacing of the crossbraces are known, the size and vertical spacing of the crossbraces, the size and vertical spacing of the wales, and the size and horizontal spacing of the uprights can be read from the appropriate table.

(f) *Examples to Illustrate the Use of Tables C-1.1 through C-1.3.*

(1) *Example 1.*

A trench dug in Type A soil is 13 feet deep and five feet wide.

From Table *C-1.1*, for acceptable arrangements of timber can be used.

Arrangement #1

Space 4×4 crossbraces at six feet horizontally and four feet vertically.

Wales are not required.

Space 3×8 uprights at six feet horizontally. This arrangement is commonly called "skip shoring."

Arrangement #2

Space 4×6 crossbraces at eight feet horizontally and four feet vertically.

Space 8×8 wales at four feet vertically.

Space 2×6 uprights at four feet horizontally.

Arrangement #3

Space 6×6 crossbraces at 10 feet horizontally and four feet vertically.

Space 8×10 wales at four feet vertically.

Space 2×6 uprights at five feet horizontally.

Arrangement #4

Space 6×6 crossbraces at 12 feet horizontally and four feet vertically.

Space 10×10 wales at four feet vertically.

Space 3×8 uprights at six feet horizontally.

(2) *Example 2.*

A trench dug in Type B soil is 13 feet deep and five feet wide. From Table C-1.2 three acceptable arrangements of members are listed.

Arrangement #1

Space 6×6 crossbraces at six feet horizontally and five feet vertically.

Space 8×8 wales at five feet vertically.

Space 2×6 uprights at two feet horizontally.

Arrangement #2

Space 6×8 crossbraces at eight feet horizontally and five feet vertically.

Space 10×10 wales at five feet vertically.

Space 2×6 uprights at two feet horizontally.

Arrangement #3

Space 8×8 crossbraces at 10 feet horizontally and five feet vertically.

Space 10×12 wales at five feet vertically.

Space 2×6 uprights at two feet vertically.

(3) *Example 3.*

A trench dug in Type C soil is 13 feet deep and five feet wide.

From Table C-1.3 two acceptable arrangements of members can be used.

Arrangement #1

Space 8×8 crossbraces at six feet horizontally and five feet vertically.

Space 10×12 wales at five feet vertically.

Position 2×6 uprights as closely together as possible.

If water must be retained use special tongue and groove uprights to form tight sheeting.

Arrangement #2

Space 8×10 crossbraces at eight feet horizontally and five feet vertically.

Space 12×12 wales at five feet vertically.

Position 2×6 uprights in a close sheeting configuration unless water pressure must be resisted. Tight sheeting must be used where water must be retained.

(4) *Example 4.*

A trench dug in Type C soil is 20 feet deep and 11 feet wide. The size and spacing of members for the section of trench that is

over 15 feet in depth is determined using Table C-1.3. Only one arrangement of members is provided.

Space 8×10 crossbraces at six feet horizontally and five feet vertically.

Space 12×12 wales at five feet vertically.

Use 3×6 tight sheeting.

Use of Tables C-2.1 through C-2.3 would follow the same procedures.

(g) Notes for all Tables.

1. Member sizes at spacings other than indicated are to be determined as specified in § 1926.652(c), "Design of Protective Systems."

2. When conditions are saturated or submerged use Tight Sheeting. Tight Sheeting refers to the use of specially-edged timber planks (e.g., tongue and groove) at least three inches thick, steel sheet piling, or similar construction that when driven or placed in position provide a tight wall to resist the lateral pressure of water and to prevent the loss of backfill material. Close Sheeting refers to the placement of planks side-by-side allowing as little space as possible between them.

3. All spacing indicated is measured center to center.

4. Wales to be installed with greater dimension horizontal.

5. If the vertical distance from the center of the lowest crossbrace to the bottom of the trench exceeds two and one-half feet, uprights shall be firmly embedded or a mudsill shall be used. Where uprights are embedded, the vertical distance from the center of the lowest crossbrace to the bottom of the trench shall not exceed 36 inches. When mudsills are used, the vertical distance shall not exceed 42 inches. Mudsills are wales that are installed at the tow of the trench side.

6. Trench jacks may be used in lieu of or in combination with timber crossbraces.

7. Placement of crossbraces. When the vertical spacing of crossbraces is four feet, place the top crossbrace no more than two feet below the top of the trench. When the vertical spacing of crossbraces is five feet, place the top crossbrace no more than 2.5 feet below the top of the trench.

Table C-1.1

Timber Trench Shoring—Minimum Timber Requirements *

Soil Type A $P_a = 25 \times H + 72$ psf (2 ft Surcharge)

Depth of Trench (feet)	Size (Actual) and Spacing of Members **													
	Cross Braces						Wales		Uprights					
	Horiz. Spacing (feet)	Width of Trench (feet)					Vert. Spacing (feet)	Size (in)	Vert. Spacing (feet)	Maximum Allowable Horizontal Spacing (feet)				
		Up to 4	Up to 6	Up to 9	Up to 12	Up to 15				Close	4	5	6	8
5 To 10	Up to 6	4×4	4×4	4×6	6×6	6×6	4	Not Req'd	—				2×6	
	Up to 8	4×4	4×4	4×6	6×6	6×6	4	Not Req'd	—					2×8
	Up to 10	4×6	4×6	4×6	6×6	6×6	4	8×8	4			2×6		
	Up to 12	4×6	4×4	4×6	6×6	6×6	4	8×8	4				2×6	
10 To 15	Up to 6	4×4	4×4	4×6	6×6	6×6	4	Not Req'd	—				3×8	
	Up to 8	4×6	4×6	6×6	6×6	6×6	4	8×8	4		2×6			
	Up to 10	6×6	6×5	6×6	6×8	6×8	4	8×10	4			2×6		
	Up to 12	6×6	6×6	6×6	6×8	6×8	4	10×10	4				3×8	
15 To 20	Up to 6	6×6	6×6	6×6	6×8	6×8	4	6×8	4	3×6				
	Up to 8	6×6	6×6	6×6	6×8	6×8	4	8×8	4	3×6				
	Up to 10	8×8	8×8	8×8	8×8	8×10	4	8×10	4	3×6				
	Up to 12	8×8	8×8	8×8	8×8	8×10	4	10×10	4	3×6				
Over 20	See Note 1													

* Mixed oak or equivalent with a bending strength not less than 850 psi.
** Manufactured members of equivalent strength may be substituted for wood.

Depth of Trench (feet) 5 To 10 | 10 To 15 | 15 To 20 | Over 20

Table C-1.2

Timber Trench Shoring—Minimum Timber Requirements *

Soil Type B $P_a = 45 \times H + 72$ psf (2 ft Surcharge)

Depth of Trench (feet)	Size (Actual) and Spacing of Members **													
	Cross Braces							Wales		Uprights				
	Horiz. Spacing (feet)	Width of Trench (feet)					Vert. Spacing (feet)	Size (in)	Vert. Spacing (feet)	Maximum Allowable Horizontal Spacing (feet)				
		Up to 4	Up to 6	Up to 9	Up to 12	Up to 15				Close	2	3		
5 To 10	Up to 6	4×6	4×6	6×6	6×6	6×6	5	6×8	5			2×6		
	Up to 8	6×6	6×6	6×6	6×8	6×8	5	8×10	5			2×6		
	Up to 10	6×6	6×6	6×6	6×8	6×8	5	10×10	5			2×6		
	See Note 1													
10 To 15	Up to 6	6×6	6×6	6×6	6×8	6×8	5	8×8	5		2×6			
	Up to 8	6×8	6×8	6×8	8×8	8×8	5	10×10	5		2×6			
	Up to 10	8×8	8×8	8×8	8×8	8×10	5	10×12	5		2×6			
	See Note 1													
15 To 20	Up to 6	6×8	6×8	6×8	8×8	8×8	5	8×10	5	3×6				
	Up to 8	8×8	8×8	8×8	8×8	8×10	5	10×12	5	3×6				
	Up to 10	8×10	8×10	8×10	8×10	10×10	5	12×12	5	3×6				
	See Note 1													
Over 20	See Note 1													

* Mixed oak or equivalent with a bending strength not less than 850 psi.
** Manufactured members of equivalent strength may be substituted for wood.

Table C-1.3

Timber Trench Shoring—Minimum Timber Requirements *

Soil Type C $P_s = 80 \times H + 72$ psf (2 ft Surcharge)

Depth of Trench (feet)	Size (Actual) and Spacing of Members **													
	Cross Braces							Wales		Uprights				
	Horiz. Spacing (feet)	Width of Trench (feet)					Vert. Spacing (feet)	Size (in)	Vert. Spacing (feet)	Maximum Allowable Horizontal Spacing (feet) (See Note 2)				
		Up to 4	Up to 6	Up to 9	Up to 12	Up to 15				Close				
5 To 10	Up to 6	6×8	6×8	6×8	8×8	8×8	5	8×10	5	2×6				
	Up to 8	8×8	8×8	8×8	8×8	8×10	5	10×12	5	2×6				
	Up to 10	8×10	8×10	8×10	8×10	10×10	5	12×12	5	2×6				
	See Note 1													
10 To 15	Up to 6	8×8	8×8	8×8	8×8	8×10	5	10×12	5	2×6				
	Up to 8	8×10	8×10	8×10	8×10	10×10	5	12×12	5	2×6				
	See Note 1													
	See Note 1													
15 To 20	Up to 6	8×10	8×10	8×10	8×10	10×10	5	12×12	5	3×6				
	See Note 1													
	See Note 1													
	See Note 1													
Over 20	See Note 1													

* Mixed oak or equivalent with a bending strength not less than 850 psi.
** Manufactured members of equivalent strength may be substituted for wood.

Table C-2.1

Timber Trench Shoring—Minimum Timber Requirements *

Soil Type A $P_s = 25 \times H + 72$ psf (2 ft Surcharge)

Depth of Trench (feet)	Size (S4S) and Spacing of Members **												
	Cross Braces						Wales		Uprights				
	Horiz. Spacing (feet)	Width of Trench (feet)					Vert. Spacing (feet)	Size (in)	Vert. Spacing (feet)	Maximum Allowable Horizontal Spacing (feet)			
		Up to 4	Up to 6	Up to 9	Up to 12	Up to 15				Close	4	5	6	8
5 To 10	Up to 6	4x4	4x4	4x4	4x4	4x6	4	Not Req'd	Not Req'd				4x6	
	Up to 8	4x4	4x4	4x4	4x6	4x6	4	Not Req'd	Not Req'd					4x8
	Up to 10	4x6	4x6	4x6	6x6	6x6	4	8x8	4			4x6		
	Up to 12	4x6	4x6	4x6	6x6	6x6	4	8x8	4				4x6	
10 To 15	Up to 6	4x4	4x4	4x4	6x6	6x6	4	Not Req'd	Not Req'd				4x10	
	Up to 8	4x6	4x6	4x6	6x6	6x6	4	6x8	4		4x6			
	Up to 10	6x6	6x6	6x6	6x6	6x6	4	8x8	4			4x8		
	Up to 12	6x6	6x6	6x6	6x6	6x6	4	8x10	4		4x6		4x10	
15 To 20	Up to 6	6x6	6x6	6x6	6x6	6x6	4	6x8	4	3x6				
	Up to 8	6x6	6x6	6x6	6x6	6x6	4	8x8	4	3x6	4x12			
	Up to 10	6x6	6x6	6x6	6x6	6x8	4	8x10	4	3x6				
	Up to 12	6x6	6x6	6x6	6x8	6x8	4	8x12	4	3x6	4x12			
Over 20	See Note 1													

* Douglas fir or equivalent with a bending strength not less than 1500 psi.
** Manufactured members of equivalent strength may be substituted for wood.

Table C-2.2

Timber Trench Shoring—Minimum Timber Requirements *

Soil Type B $P_s = 45 \times H + 72$ psf (2 ft Surcharge)

Depth of Trench (feet)	Size (S4S) and Spacing of Members **													
	Cross Braces						Wales		Uprights					
	Horiz. Spacing (feet)	Width of Trench (feet)					Vert. Spacing (feet)	Size (in)	Vert. Spacing (feet)	Maximum Allowable Horizontal Spacing (feet)				
		Up to 4	Up to 6	Up to 9	Up to 12	Up to 15				Close	2	3	4	6
5 To 10	Up to 6	4×6	4×6	4×6	6×6	6×6	5	6×8	5			3×12 4×8		4×12
	Up to 8	4×6	4×6	6×6	6×6	6×6	5	8×8	5		3×8		4×8	
	Up to 10	4×6	4×6	6×6	6×6	6×8	5	8×10	5			4×8		
	See Note 1													
10 To 15	Up to 6	6×6	6×6	6×6	6×8	6×8	5	8×8	5	3×6	4×10			
	Up to 8	6×8	6×8	6×8	8×8	8×8	5	10×10	5	3×6	4×10			
	Up to 10	6×8	6×8	8×8	8×8	8×8	5	10×12	5	3×6	4×10			
	See Note 1													
15 To 20	Up to 6	6×8	6×8	6×8	6×8	8×8	5	8×10	5	4×6				
	Up to 8	6×8	6×8	6×8	8×8	8×8	5	10×12	5	4×6				
	Up to 10	8×8	8×8	8×8	8×8	8×8	5	12×12	5	4×6				
	See Note 1													
Over 20	See Note 1													

* Douglas fir or equivalent with a bending strength not less than 1500 psi.

** Manufactured members of equivalent strength may be substituted for wood.

Table C-2.3

Timber Trench Shoring—Minimum Timber Requirements

Soil Type C $P_a = 80 \times H + 72$ psf (2 ft Surcharge)

Depth of Trench (feet)	Size (S4S) and Spacing of Members **													
	Cross Braces							Wales		Uprights				
	Horiz. Spacing (feet)	Width of Trench (feet)					Vert. Spacing (feet)	Size (in)	Vert. Spacing (feet)	Maximum Allowable Horizontal Spacing (feet)				
		Up to 4	Up to 6	Up to 9	Up to 12	Up to 15				Close				
5 To 10	Up to 6	6×6	6×6	6×6	6×6	8×8	5	8×8	5	3×6				
	Up to 8	6×6	6×6	6×6	8×8	8×8	5	10×10	5	3×6				
	Up to 10	6×6	6×6	8×8	8×8	8×8	5	10×12	5	3×6				
	See Note 1													
10 To 15	Up to 6	6×8	6×8	6×8	8×8	8×8	5	10×10	5	4×6				
	Up to 8	8×8	8×8	8×8	8×8	8×8	5	12×12	5	4×6				
	See Note 1													
	See Note 1													
15 To 20	Up to 6	8×8	8×8	8×8	8×10	8×10	5	10×12	5	4×6				
	See Note 1													
	See Note 1													
	See Note 1													
Over 20	See Note 1													

* Douglas fir or equivalent with a bending strength not less than 1500 psi.
** Manufactured members of equivalent strength may be substituted for wood.

Appendix D to § 1926 Subpart P—
Aluminum Hydraulic Shoring for Trenches

(a) Scope. This appendix contains information that can be used when aluminum hydraulic shoring is provided as a method of protection against cave-ins in trenches that do not exceed 20 feet (6.1m) in depth. This appendix must be used when design of the aluminum hydraulic protective system cannot be performed in accordance with § 1926.652(c)(2).

(b) *Soil Classification.* In order to use data presented in this appendix, the soil type or types in which the excavation is made must first be determined using the soil classification method set forth in appendix A of subpart P of part 1926.

(c) *Presentation of Information.* Information is presented in several forms as follows:

(1) Information is presented in tabular form in Tables D-1.1, D-1.2, D-1.3 and D-1.4. Each table presents the maximum vertical and horizontal spacings that may be used with various aluminum member sizes and various hydraulic cylinder sizes. Each table contains data only for the particular soil type in which the excavation or portion of the excavation is made. Tables D-1.1 and D-1.2 are for vertical shores in Types A and B soil. Tables D-1.3 and D-1.4 are for horizontal waler systems in Types B and C soil.

(2) Information concerning the basis of the tabular data and the limitations of the data is presented in paragraph (d) of this appendix.

(3) Information explaining the use of the tabular data is presented in paragraph (e) of this appendix.

(4) Information illustrating the use of the tabular data is presented in paragraph (f) of this appendix.

(5) Miscellaneous notations (Footnotes) regarding Table D-1.1 through D-1.4 are presented in paragraph (g) of this appendix.

(6) Figures, illustrating typical installations of hydraulic shoring, are included just prior to the Tables. The illustrations page is entitled "Aluminum Hydraulic Shoring: Typical Installations."

(d) *Basis and limitations of the data.*

(1) Vertical shore rails and horizontal wales are those that meet the Section Modulus requirements in the D-1 Tables. Aluminum material is 6061-T6 or material of equivalent strength and properties.

(2) Hydraulic cylinders specifications. (i) 2-inch cylinders shall be a minimum 2-inch inside diameter with a minimum safe working capacity of no less than 18,000 pounds axial compressive load at maximum extension. Maximum extension is to include full range of cylinder extensions as recommended by product manufacturer.

(ii) 3-inch cylinders shall be a minimum 3-inch inside diameter with a safe working capacity of not less than 30,000 pounds axial compressive load at extensions as recommended by product manufacturer.

(3) Limitation of application.

(i) It is not intended that the aluminum hydraulic specification apply to every situation that may be experienced in the field. These data were developed to apply to the situations that are most commonly experienced in current trenching practice. Shoring systems for use in situations that are not covered by the data in this appendix must be otherwise designed as specified in § 1926.652(c).

(ii) When any of the following conditions are present, the members specified in the Tables are not considered adequate. In this case, an alternative aluminum hydraulic shoring system or other type of protective system must be designed in accordance with § 1926.652.

(A) When vertical loads imposed on cross braces exceed a 100 Pound gravity load distributed on a one foot section of the center of the hydraulic cylinder.

(B) When surcharge loads are present from equipment weighing in excess of 20,000 pounds.

(C) When only the lower portion of a trench is shored and the remaining portion of the trench is sloped or benched unless: The sloped portion is sloped at an angle less steep than three horizontal to one vertical; or the members are selected from the tables for use at a depth which is determined from the top of the overall trench, and not from the toe of the sloped portion.

(e) *Use of Tables D-1.1, D-1.2, D-1.3 and D-1.4.* The members of the shoring system that are to be selected using this information are the hydraulic cylinders, and either the vertical shores or the horizontal wales. When a waler system is used the vertical timber sheeting to be used is also selected from these tables. The Tables D-1.1 and D-1.2 for vertical shores are used in Type A and B soils that do not require sheeting. Type B soils that may require sheeting, and Type C soils that always require sheeting, are found in the horizontal waie Tables D-1.3 and D-1.4. The soil type must first be determined in accordance with the soil classification system described in appendix A to subpart P of part 1926. Using the appropriate table, the selection of the size and spacing of the members is made. The selection is based on the depth and width of the trench where the members are to be installed. In these tables the vertical spacing is held constant at four feet on center. The tables show the maximum horizontal spacing of cylinders allowed for each size of wale in the waler system tables, and in the vertical shore tables, the hydraulic cylinder horizontal spacing is the same as the vertical shore spacing.

(f) *Example to Illustrate the Use of the Tables:*

(1) Example 1:

A trench dug in Type A soil is 6 feet deep and 3 feet wide. From Table D-1.1: Find vertical shores and 2 inch diameter cylinders spaced 8 feet on center (o.c.) horizontally and 4 feet on center (o.c.) vertically. (See Figures 1 & 3 for typical installations.)

(2) Example 2:

A trench is dug in Type B soil that does not require sheeting, 13 feet deep and 5 feet wide. From Table D-1.2: Find vertical shores and 2 inch diameter cylinders spaced 6.5 feet o.c. horizontally and 4 feet o.c. vertically. (See Figures 1 & 3 for typical installations.)

(3) A trench is dug in Type B soil that does not require sheeting, but does experience some minor raveling of the trench face. the trench is 16 feet deep and 9 feet wide. From Table D-1.2: Find vertical shores and 2 inch diameter cylinder (with special oversleeves as designated by Footnote #2) spaced 5.5 feet o.c. horizontally and 4 feet o.c. vertically. Plywood (per Footnote (g)(7) to the D-1 Table) should be used behind the shores. (See Figures 2 & 3 for typical installations.)

(4) Example 4: A trench is dug in previously disturbed Type B soil, with characteristics of a Type C soil, and will require sheeting. The trench is 18 feet deep, and 12 feet wide 8 foot horizontal spacing between cylinders is desired for working space. From Table D-1.3: Find horizontal wale with a section modulus of 14.0 spaced at 4 feet o.c. vertically and 3 inch diameter cylinder spaced at 9 feet maximum o.c. horizontally, 3 x 12 timber sheeting is required at close spacing vertically. (See Figure 4 for typical installation.)

(5) Example 5: A trench is dug in Type C soil, 9 feet deep and 4 feet wide. Horizontal cylinder spacing in excess of 6 feet is desired for working space. From Table D-1.4: Find horizontal wale with a section modulus of 7.0 and 2 inch diameter cylinders spaced at 6.5 feet o.c. horizontally. Or, find horizontal wale with a 14.0 section modulus and 3 inch diameter cylinder spaced at 10 feet o.c. horizontally. Both wales are spaced 4 feet o.c. vertically, 3 x 12 timber sheeting is required at close spacing vertically. (See Figure 4 for typical installation.)

(g) *Footnotes, and general notes, for Tables D-1.1, D-1.2, D-1.3, and D-1.4.*

(1) For applications other than those listed in the tables, refer to § 1926.652(c)(2) for use of manufacturer s tabulated data. For trench depths in excess of 20 feet, refer to § 1926.652(c)(2) and § 1926.652(c)(3).

(2) 2-inch diameter cylinders, at this width, shall have structural steel tube (3.5 x 3.5 x 0.1875) oversleeves, or structural oversleeves of manufacturer's specification, extending the full, collapsed length.

(3) Hydraulic cylinders capacities. (i) 2-inch cylinders shall be a minimum 2-inch inside diameter with a safe working capacity of not less than 18,000 pounds axial compressive load at maximum extension. Maximum extension is to include full range of cylinder extensions as recommended by product manufacturer.

(ii) 3-inch cylinders shall be a minimum 3-inch inside diameter with a safe work capacity of not less than 30,000 pounds axial compressive load at maximum extension. Maximum extension is to include full range of cylinder extensions as recommended by product manufacturer.

(4) All spacing indicated is measured center to center.

(5) Vertical shoring rails shall have a minimum section modulus of 0.40 inch.

(6) When vertical shores are used, there must be a minimum of three shores spaced equally, horizontally, in a group.

(7) Plywood shall be 1.125 inch thick softwood or 0.75 inch thick, 14 ply, arctic white birch (Finland form). Please note that plywood is not intended as a structural member, but only for prevention of local raveling (sloughing of the trench face) between shores.

(8) See appendix C for timber specifications.

(9) Wales are calculated for simple span conditions.

(10) See appendix D, item (d), for basis and limitations of the data.

ALUMINUM HYDRAULIC SHORING
TYPICAL INSTALLATIONS

FIGURE NO. 1

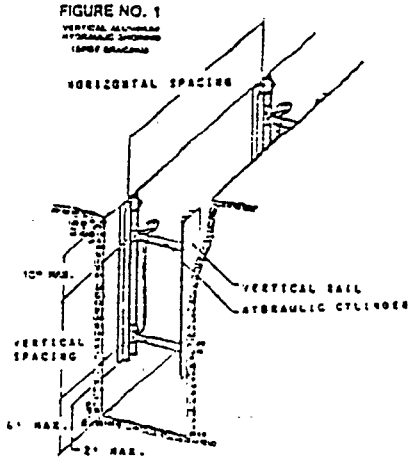


FIGURE NO. 2

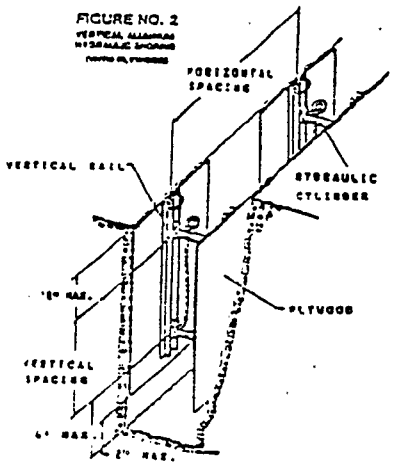


FIGURE NO. 3

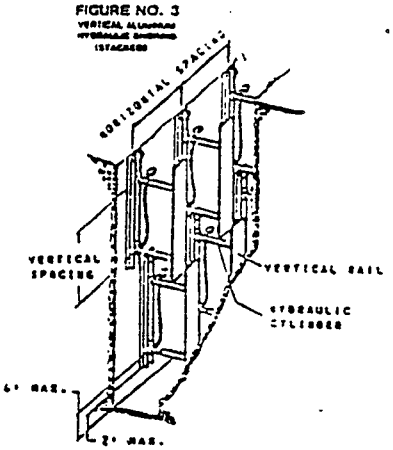


FIGURE NO. 4

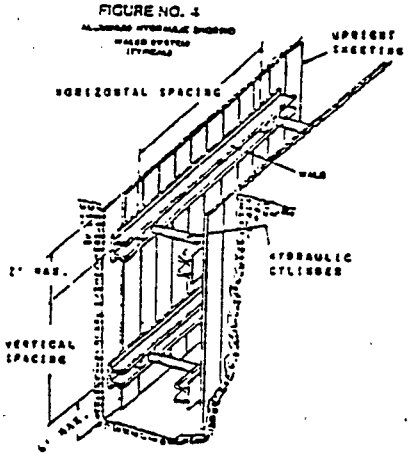


Table D-1.1

Aluminum Hydraulic Shoring

Vertical Shores
For Soil Type A

Depth of Trench (feet)	Hydraulic Cylinders				
	Maximum Horizontal Spacing (feet)	Maximum Vertical Spacing (feet)	Width of Trench (feet)		
			Up to 8	Over 8 Up to 12	Over 12 Up to 15
Over 5 Up to 10	8	4	2 inch Diameter	2 inch Diameter Note (2)	3 inch Diameter
Over 10 Up to 15	8				
Over 15 Up to 20	7				
Over 20	Note (1)				

Footnotes to tables, and general notes on hydraulic shoring, are found in Appendix D, Item (g)
Note (1): See Appendix D, Item (g)(1)
Note (2): See Appendix D, Item (g)(2)

Table D-1.2

Aluminum Hydraulic Shoring

Vertical Shores
For Soil Type B

Depth of Trench (feet)	Hydraulic Cylinders				
	Maximum Horizontal Spacing (feet)	Maximum Vertical Spacing (feet)	Width of Trench (feet)		
			Up to 8	Over 8 Up to 12	Over 12 Up to 15
Over 5 Up to 10	8	4	2 inch Diameter	2 inch Diameter Note (2)	3 inch Diameter
Over 10 Up to 15	6.5				
Over 15 Up to 20	5.5				
Over 20	Note (1)				

Footnotes to tables, and general notes on hydraulic shoring, are found in Appendix D, Item (g)
Note (1): See Appendix D, Item (g)(1)
Note (2): See Appendix D, Item (g)(2)

Table D-1.3
Aluminum Hydraulic Shoring
Waler Systems
For Soil Type B

Depth of Trench (feet)	Wales		Hydraulic Cylinders						Timber Uprights		
			Width of Trench (feet)						Max. Horiz. Spacing (on Center)		
			Up to 8		Over 8 Up to 12		Over 12 Up to 15				
	Vertical Spacing (feet)	Section Modulus (in^3)	Horiz. Spacing	Cylinder Diameter	Horiz. Spacing	Cylinder Diameter	Horiz. Spacing	Cylinder Diameter	Solid Sheet	2 ft.	3 ft.
Over 5 Up to 10	4	3.5	8.0	2 in	8.0	2 in Note(2)	8.0	3 in	—	—	3×12
		7.0	9.0	2 in	9.0	2 in Note (2)	9.0	3 in			
		14.0	12.0	3 in	12.0	3 in	12.0	3 in			
Over 10 Up to 15	4	3.5	6.0	2 in	6.0	2 in Note(2)	6.0	3 in	—	3×12	—
		7.0	8.0	3 in	8.0	3 in	8.0	3 in			
		14.0	10.0	3 in	10.0	3 in	10.0	3 in			
Over 15 Up to 20	4	3.5	5.5	2 in	5.5	2 in Note(2)	5.5	3 in	3×12	—	—
		7.0	6.0	3 in	6.0	3 in	6.0	3 in			
		14.0	9.0	3 in	9.0	3 in	9.0	3 in			
Over 20	Note(1)										

Footnotes to tables, and general notes on hydraulic shoring, are found in Appendix D, Item (g)
Notes (1): See Appendix D, Item (g)(1)
Notes (2): See Appendix D, Item (g)(2)
* Consult product manufacturer and/or qualified engineer for Section Modulus of available wales.

Table D-1.4
Aluminum Hydraulic Shoring
Waler Systems
For Soil Type C

Depth of Trench (feet)	Wales		Hydraulic Cylinders						Timber Uprights		
			Width of Trench (feet)						Max. Horiz. Spacing (on Center)		
			Up to 8		Over 8 Up to 12		Over 12 Up to 15		Solid Sheet	2 ft.	3 ft.
	Vertical Spacing (feet)	Section Modulus (in^3)	Horiz. Spacing	Cylinder Diameter	Horiz. Spacing	Cylinder Diameter	Horiz. Spacing	Cylinder Diameter			
Over 5 Up to 10	4	3.5	6.0	2 in	6.0	2 in Note(2)	6.0	3 in	3×12	—	—
		7.0	6.5	2 in	6.5	2 in Note (2)	6.5	3 in			
		14.0	10.0	3 in	10.0	3 in	10.0	3 in			
Over 10 Up to 15	4	3.5	4.0	2 in	4.0	2 in Note(2)	4.0	3 in	3×12	—	—
		7.0	5.5	3 in	5.5	3 in	5.5	3 in			
		14.0	8.0	3 in	8.0	3 in	8.0	3 in			
Over 15 Up to 20	4	3.5	3.5	2 in	3.5	2 in Note(2)	3.5	3 in	3×12	—	—
		7.0	5.0	3 in	5.0	3 in	5.0	3 in			
		14.0	6.0	3 in	6.0	3 in	6.0	3 in			
Over 20	Note(1)										

Footnotes to tables, and general notes on hydraulic shoring, are found in Appendix D, Item (g)
Notes (1): See Appendix D, Item (g)(1)
Notes (2): See Appendix D, Item (g)(2)
* Consult product manufacturer and/or qualified engineer for Section Modulus of available wales.

APPENDIX E TO SUBPART P—ALTERNATIVES TO TIMBER SHORING

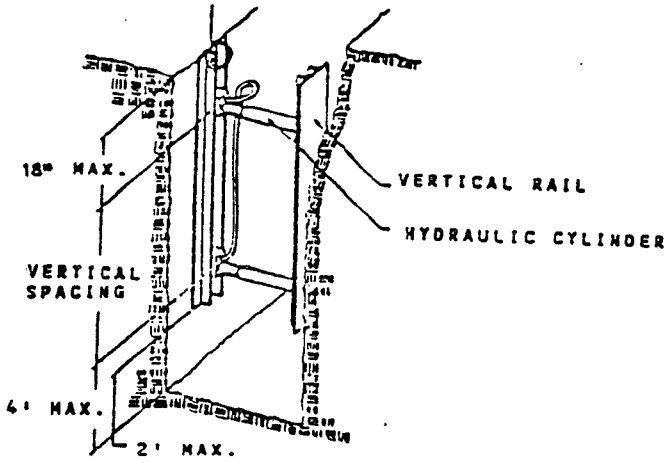


Figure 1. Aluminum Hydraulic Shoring

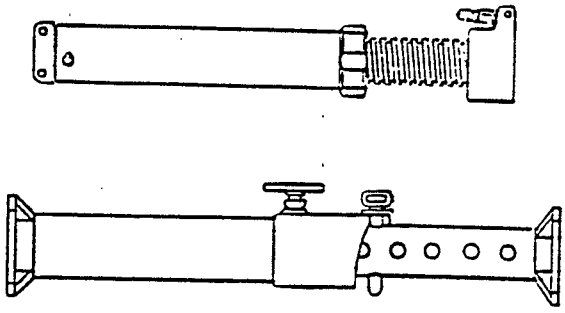


Figure 2. Pneumatic/hydraulic Shoring

Footnotes to tables, and general notes on hydraulic shorir found in Appendix D, Item (g)
Notes (1): See Appendix D, Item (g)(1)
Notes (2): See Appendix D, Item (g)(2)
• Consult product manufacturer and/or qualified engineer for Section Modulus of available wales.

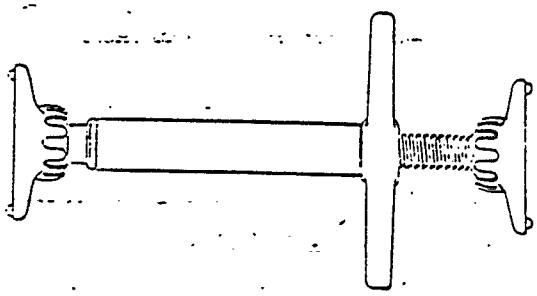


Figure 3. Trench Jacks (Screw Jacks)

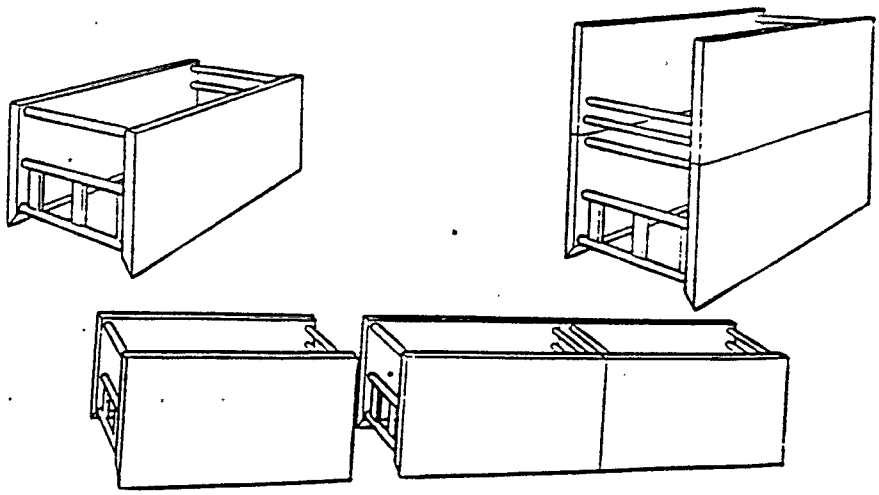


Figure 4. Trench Shields

Appendix F to § 1926 Subpart P—Selection of Protective Systems

The following figures are a graphic summary of the requirements contained in subpart P for excavations 20 feet or less in depth. Protective systems for use in excavations more than 20 feet in depth must be designed by a registered professional engineer in accordance with § 1926.652(b) and (c).

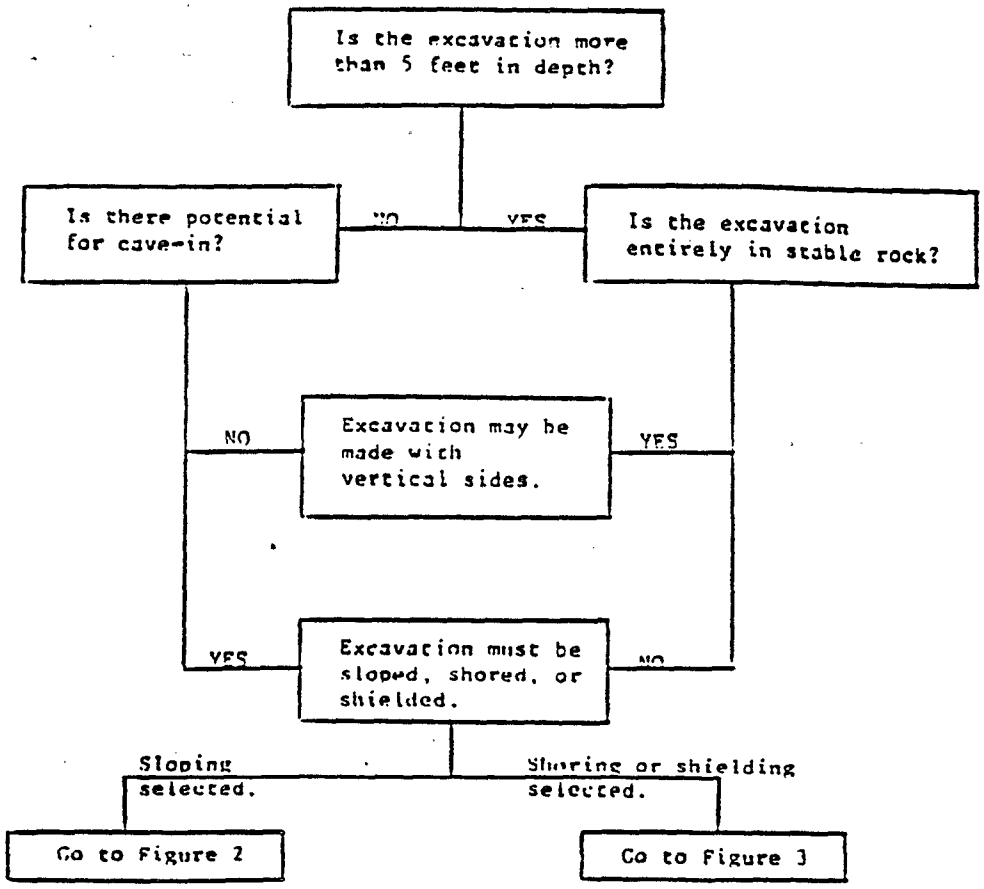


FIGURE 1 - PRELIMINARY DECISIONS

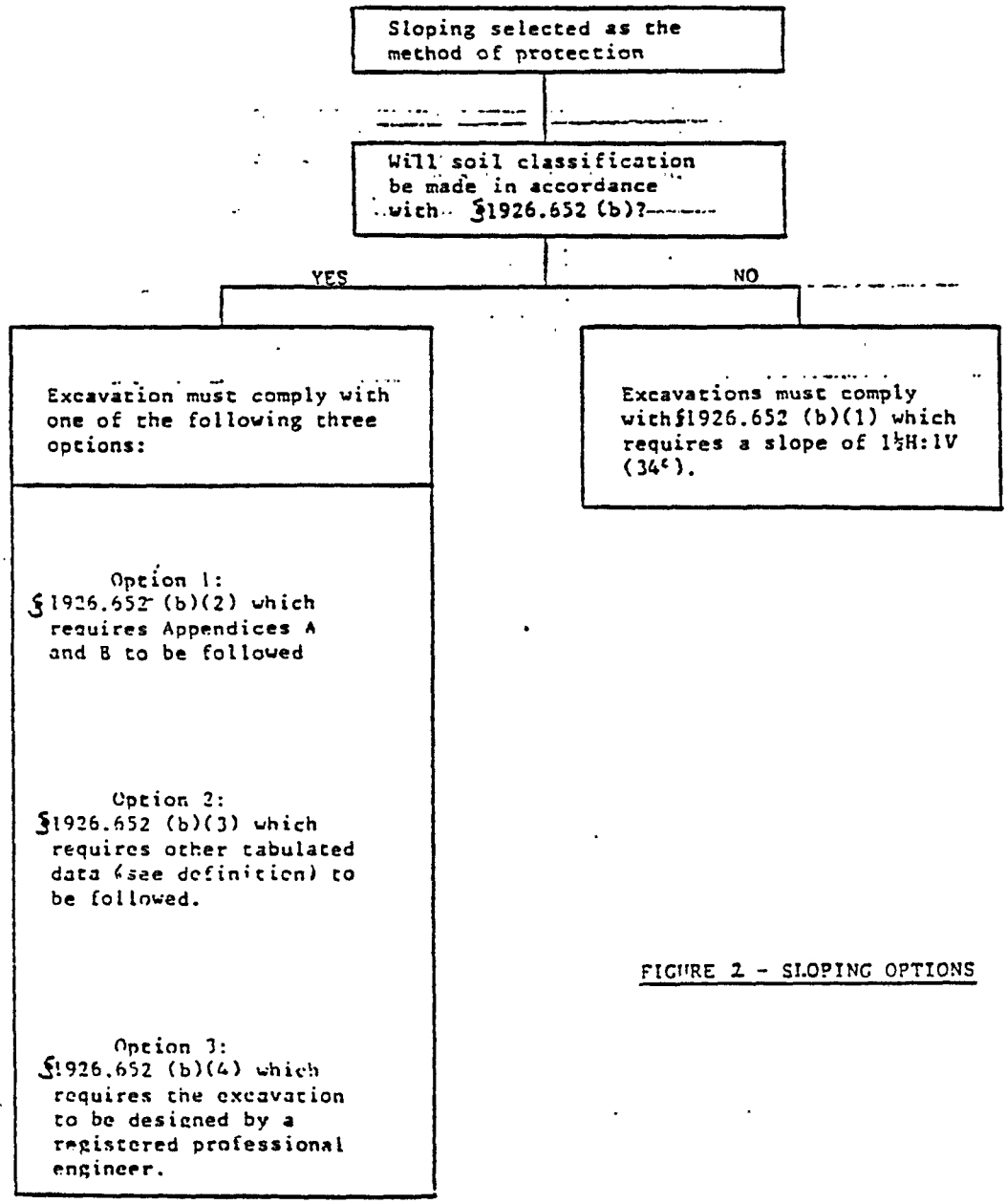


FIGURE 2 - SLOPING OPTIONS

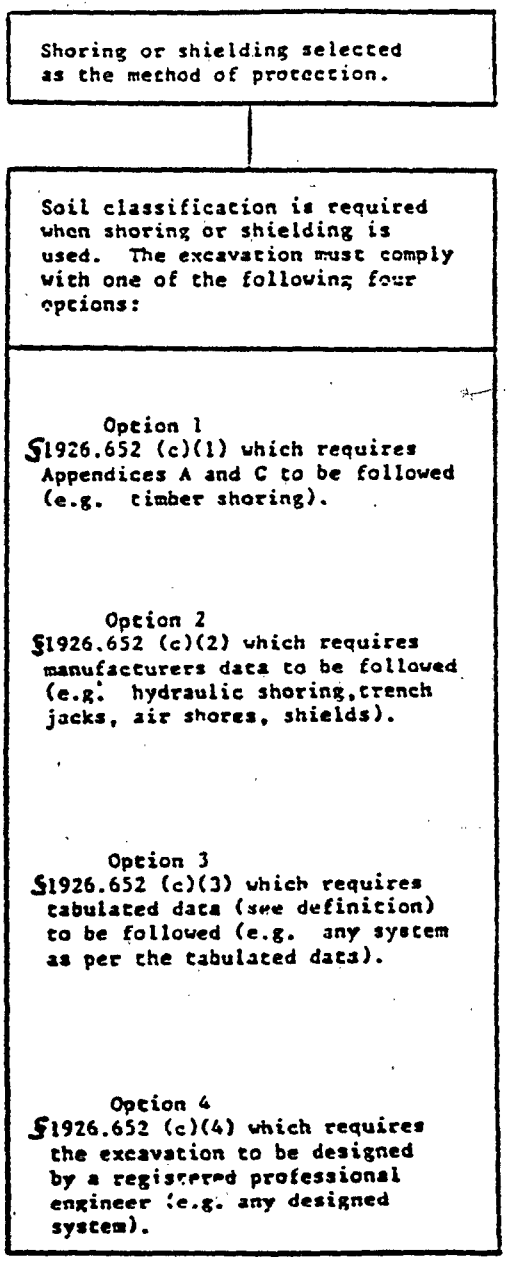


FIGURE 3 - SHORING AND SHIELDING OPTIONS

ATTACHMENT H

DRAFT

HEALTH AND SAFETY PROGRAM

FOR

HAZARDOUS WASTE OPERATIONS

SECTION IXX

HEALTH AND SAFETY PROCEDURE #12
WORK ZONES FOR HAZARDOUS WASTE SITES

Revisions	Date

Langan
Engineering and Environmental Services, Inc.

SECTION IXX
HEALTH AND SAFETY PROCEDURE #12
WORK ZONES FOR HAZARDOUS WASTE SITES

TABLE OF CONTENTS

19.0 PURPOSE

Work zones must be established and demarcated on site covered by 29 CFR 1910.120. This procedure provides general reference information on site control and the establishment of work zones.

19.1 Scope

Work activities involving hazardous substances may contribute to the movement of materials (contaminants) from the site to unaffected areas. To minimize the transfer of hazardous substance(s) from the site, two general contamination control methods are used; establishing site work zones and decontamination. This procedure includes general guidelines for the establishment of work zones and is applicable to all Langan Engineering & Environmental Services, Inc. (Langan) site activities where exposure to hazardous materials may occur. 29 CFR 1910.120 requires the identification of work zones for sites covered by the standard. A site specific health and safety plan (HASP) may include additional precautions beyond the guidelines established in this procedure.

19.2 Definitions

Contaminated Materials - Contaminated materials are defined as 1) any material that is suspected or known to be contaminated with a potentially hazardous material that is in the process of being remediated and 2) any by-product of a field investigation that is suspected or known to be contaminated with a potentially hazardous substances. Contaminated materials may include decontamination solutions, disposable equipment and clothing, drilling mud, well-development fluids, waste materials involved in remediation, excavated soils, and spill-contaminated materials.

19.3 Responsibilities

Project Manager - The Project Manager is responsible for ensuring that project-specific plans are in compliance with these procedures.

Health and Safety Coordinator (HSC) - Responsible for implementing / enforcing / designating zones on-site.

19.4 Procedures

Establishing work zones is an effective method of minimizing the transfer of hazardous substance(s) from a site.

19.4.1 Site Control

The possibility of translocation of substances can be minimized by:

1. Setting up security and physical barriers to exclude unnecessary personnel from the general area;

2. Minimizing the number of personnel and equipment at the site consistent with effective operations;

3. Establishing work zones within the site; and

4. Establishing control points to regulate access to work zones.

19.4.2 Site Security

Site security during work hours should be controlled: 1) at the support zone; and 2) at the access control points of the contamination reduction zone. For most sites, security may be implemented by observing and patrolling the site boundary or posting signs around the perimeter.

The field team should be alert for unauthorized personnel. Evacuation may be necessary if the unauthorized personnel create a danger to the health and safety of the work parties. If the site presents a significant risk to the health and safety of the local populace, local police support may be requested for additional security.

If necessary, site security after hours may be provided by: 1) a barrier; or 2) security personnel. A fence or barrier around the site may be required to prevent unauthorized personnel from entering the site. Equipment should be locked within a fence or trailer or removed from the site each day. An alternative for large sites is to employ a security guard or have the local police patrol the area.

19.4.3 Delineation of Work Zones

Work zones are used to prevent or reduce the migration of contamination. The three recommended contiguous zones are provided below.

Zone 1: Exclusion Zone
Zone 2: Contamination Reduction Zone
Zone 3: Support Zone

Less stringent site control and decontamination procedures may be used if more definitive information is available on the types of substances involved, their locations, and the hazards they present.

19.4.3.1 Zone 1: Exclusion Zone

The Exclusion Zone is the zone where contamination may exist. An entry and exit checkpoint must be established at the periphery of the Exclusion Zone to regulate the flow of personnel and equipment into and out of the zone.

The outer boundary of this zone, the Hotline, is initially established by visually surveying the area and determining where hazardous substances, drainage, leachate, or spilled material may be located, and whether any discolorations are visible, or from data from the initial site survey.

Additional factors that should be considered include:

- The distances needed to prevent fire or an explosion from affecting personnel outside the zone;
- The physical area necessary to conduct site operations; and
- The potential for contaminants to be blown from the area.

The Hotline must be physically marked or fenced. The boundary may be modified and adjusted as more information becomes available.

All personnel within the Exclusion Zone must wear the required level of personal protective equipment established in the HASP.

19.4.3.2 Zone 2: Contamination Reduction Zone

The Contamination Reduction Zone is located between the Exclusion Zone and the Support Zone and provides a transition between contaminated and clean zones. It serves as a buffer to reduce the probability of the clean zone becoming contaminated. Within the Contamination Reduction Zone lies the Contamination Reduction Corridor (CRC). This corridor begins at the boundary of the Exclusion Zone and is the area where the decontamination stations are established. Exit from the Exclusion Zone must always be through a decontamination station.

The size and location of the CRC depends on the wind direction (up or side wind), the number of stations in the decontamination procedure, the overall dimension of work control zones, and the amount of space available at the site. An area of 75 by 15 feet should be adequate for most corridors.

Personnel in the CRC must wear the personal protective equipment designated for the decontamination crew. Another corridor may be required for the entrance and exit of heavy equipment needing decontamination.

Access to the CRC should be limited to personnel wearing the appropriate protection and activities should be limited to decontamination.

Factors to consider when organizing the CRC and selecting decontaminants include:

- The extent and type of hazard expected;
- Explosive potential;
- Meteorological conditions;
- Topography;
- Levels of protection; and
- Availability of equipment and supplies.

19.4.3.3 Zone 3: Support Zone

The Support Zone is considered to be a non-contaminated or clean area. Support equipment (command post, equipment trailer, etc.) shall be located in the zone and

traffic shall be restricted to authorized response personnel. Normal work clothes are appropriate within this zone; potentially contaminated personnel clothing, equipment, and samples must be left in the Contamination Reduction Zone until they are decontaminated.

The location of the command post and other support facilities in the Support Zone depends on the factors below.

1. Accessibility - The topography, available open space, and the locations of highways and railroad tracks.

2. Wind Direction - The support facilities shall be located upwind of the Exclusion Zone. Shifts in wind direction and other conditions may be such that an ideal location determined on the basis of wind direction alone does not exist.

3. Resources - There should be adequate roads, power lines, water, and shelter.

19.4.4 Area Dimensions

The distance, size and shape of each zone must be based on conditions specific to each site. Distances between zone boundaries should be sufficient to allow room for the necessary operations, provide adequate distances to prevent the spread of contaminants, and eliminate the possibility of injury due to explosion or fire. Long-term operations should involve developing reasonable methods to determine if material is being transferred between zones and to assist in modifying site boundaries.

The following criteria shall be considered in establishing area dimensions and boundary distances:

1. Physical and topographical features of the site;

2. Weather conditions;

3. Field/laboratory measurements of air contaminants and environmental samples;

4. Air dispersion calculations;

5. Potential for explosion and flying debris;
6. Physical, chemical, toxicological, and other characteristics of the substances present;
7. Cleanup activities required;
8. Potential for fire;
9. Area needed to conduct operations;
10. Decontamination procedures;
11. Dimensions of contaminated area; and
12. Potential for exposure.

19.5 References

29 CFR 1910.120 "Hazardous Waste Operations and Emergency Response."

Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, DHHS (NIOSH) No. 85-115.

19.6 Attachments

None.

ATTACHMENT I

HEALTH AND SAFETY PROGRAM

FOR

HAZARDOUS WASTE OPERATIONS

SECTION XX

HEALTH AND SAFETY PROCEDURE #13
DECONTAMINATION

Revisions	Date

Langan
Engineering and Environmental Services, Inc.

SECTION XX
HEALTH AND SAFETY PROCEDURE #13
DECONTAMINATION

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20.0 PURPOSE

This procedure establishes general decontamination procedures for sites involving potential exposure to hazardous materials. 29 CFR 1910.120 requires decontamination procedures be established when working on sites covered by the standard. A site specific health and safety plan (HASP) shall detail decontamination procedures. Decontamination procedures are good practice on any site where exposure to potentially hazardous materials occur.

20.1 Scope

This procedure applies to Langan Engineering & Environmental Services, Inc. (Langan) activities where exposure to hazardous materials may occur.

20.2 Definitions

None.

20.3 Responsibilities

Health & Safety Coordinator (HSC) - The HSC shall develop adequate site-specific decontamination procedures for inclusion in the HASP.

Health & Safety Manager (HSM) - The HSM shall oversee the assigned HSC's development of adequate decontamination procedures to prevent contamination of individuals or contamination of the environment beyond the Exclusion Zone.

Project Manager (PM) - The Project Manager will provide sufficient information to the HSC to allow for adequate decontamination procedures for inclusion in the site-specific HASP.

Site Personnel - It is the responsibility of all site personnel to follow the decontamination procedures as outlined in the HASP.

20.4 Procedures

20.4.1 Introduction

Despite contamination avoidance practices and personal protective equipment, personnel and equipment working with hazardous materials may become contaminated during the course of work. Decontamination procedures are designed to:

1) Remove any contaminant that may remain;

2) Avoid spreading the contamination; and

3) Avoid exposing unprotected personnel to contaminants.

Decontamination involves physically removing contaminants and/or converting them chemically into innocuous substances. Based on the materials anticipated at the site, specific decontamination procedures should be outlined in each site specific HASP.

20.4.2 Preliminary Concerns

20.4.2.1 Contamination Avoidance

Contamination avoidance is the primary method for preventing spread of contamination from a hazardous site. Some techniques for contamination avoidance are provided below.

- Know the limitations of all protective equipment being used.
- Do not enter a contaminated area unless it is necessary to carry out a specific objective.
- When in a contaminated area, avoid touching anything unnecessarily.
- Walk around pools of liquids, discolored areas, or any area that shows evidence of possible contamination.
- Walk upwind of contamination, if possible.
- Do not sit or lean against anything in a contaminated area. If you must kneel (e.g., to take samples), use a plastic ground sheet.

- Before sampling any hazardous waste, read the label and manifest (if available) for all containers to determine the identity of the substance and its potential for contamination. Be cautious - the label may not accurately reflect contents.
- While checking for waste contents, also check for potential incompatibility of wastes.
- If at all possible, do not set sampling equipment directly on contaminated areas. Place equipment on a protective cover such as a ground cloth.
- Use the proper tools necessary to safely conduct the study.

Specific methods that may reduce the chance of contamination are:

- Use remote sampling techniques;
- Open containers by nonmanual means;
- Bag monitoring instruments;
- Use drum grapplers; and
- Water down dusty areas.

20.4.2.2 Initial Planning

The initial decontamination plan may change based on the specific conditions found at a work site and specified in the HASP. Factors to consider when developing decontamination procedures include:

- The extent and type of hazard expected;
- Explosive potential;
- Meteorological conditions;
- Topography;
- Levels of protection selected;

- Availability of equipment and supplies; and
- Disposal of wastes and wash/rinse water.

Decontamination procedures should establish:

- Stations for each of piece of clothing or equipment removed from the Exclusion Zone; and
- A sequence for proceeding through the stations.

The procedure should define a sequence of washing, rinsing, and removal or disposal of the most heavily contaminated articles first and continue the process to the least contaminated articles. Each piece of clothing or equipment requires a separate station in order to prevent cross contamination.

If no information is available about the work area, the decontamination plan must be based on a worst-case scenario. All of the protective equipment and clothing worn shall be washed and rinsed, at least once, in combination with the sequential removal of such items.

20.4.2.3 Site Organization

Decontamination occurs within the Contamination Reduction Zone (CRZ) in the site's Contamination Reduction Corridor (CRC). Personnel exiting the Exclusion Zone must go through the CRC. A separate corridor may be established for heavy equipment.

20.4.3 Decontamination Guidance

The equipment necessary for decontamination depends upon the personal protection selected, the specific pieces of clothing worn, and the type of equipment used. The time required for personnel decontamination must be incorporated in the scheduling of site activities.

The extent of decontamination may be adjusted based on the reason for leaving the Exclusion Zone. Individuals departing the CRC at break time, lunchtime, or the end of the day must be thoroughly decontaminated. Activities that require leaving the Exclusion Zone, but may not require full decontamination may include: picking up or dropping off tools or instruments and immediately returning; getting a new air

cylinder or changing a respirator cartridge; and exiting to follow a work/rest regimen established to prevent heat stress.

The type of decontamination equipment, materials, and supplies shall be selected on the basis of availability, the ease of equipment decontamination, and disposal requirements. Commonly used equipment include:

- Soft-bristle scrub brushes or long-handled brushes for scrubbing;
- Buckets of water or garden sprayers for rinsing;
- Large galvanized wash tubs, stock tanks, or children's wading pools for wash and rinse solutions;
- Large plastic garbage cans or similar containers lined with plastic bags for the storage of contaminated clothing and equipment;
- Metal or plastic cans and drums for the temporary storage of contaminated liquids; and
- Paper or cloth towels for drying protective clothing and equipment.

Protective equipment, sampling tools, and other equipment are usually decontaminated by scrubbing with detergent water using a soft-bristle brush followed by rinsing with copious amounts of water.

If a decontaminating solution is to be used, the contaminant must be identified before selecting a chemical. Reactions of decontaminating solutions with unidentified substances or mixtures could present potential hazards.

Once decontamination procedures have been established, all personnel requiring decontamination must be given precise instructions.

Heavy equipment such as bulldozers, trucks, backhoes, and drilling equipment are difficult to decontaminate. The common procedure is to wash the equipment on a sloped concrete or plastic covered pad with a soapy water solution and a thorough water rinse utilizing a high pressure spray unit. Particular attention should be given to the tires, the scoop, and other components which contact the contaminated areas.

Wipe test may be conducted to determine the effectiveness of the decontamination procedure. Wash water must be collected for proper disposal.

20.4.4 Closure of Contamination Reduction Corridor

When the CRC is no longer needed, it must be closed. All disposable clothing and plastic sheeting used during the operation must be double-bagged and disposed of appropriately. Reusable rubber clothing should be fully decontaminated, dried and prepared for future use. Cloth items must be bagged and removed from the site for final cleaning. All wash tubs, pails, containers, etc., must be thoroughly washed, rinsed, and dried prior to removal from the site.

20.5 References

29 CFR 1910.120 "Hazardous Waste Operations and Emergency Response"

Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities. DHHS (NIOSH) No. 85-115.

20.6 Attachments

None.

ATTACHMENT J

HEALTH AND SAFETY PROGRAM

FOR

HAZARDOUS WASTE OPERATIONS

SECTION XXI

HEALTH AND SAFETY PROCEDURE #14
AIR MONITORING AND SAMPLING

Revisions	Date

Langan
Engineering and Environmental Services, Inc.

SECTION XXI
HEALTH AND SAFETY PROCEDURE #14
AIR MONITORING AND SAMPLING

TABLE OF CONTENTS

21.0 PURPOSE

This procedure establishes environmental air monitoring guidelines for sites covered under 29 CFR 1910.120 where potential exposure to hazardous materials may occur. Environmental air monitoring may be used to assist with establishing criteria for worker safety, document potential exposures, determine protective measures for the public, evaluate the potential environmental impact of the site and determine mitigation activities. Activities on sites regulated by 29 CFR 1910.120 must include air monitoring and/or sampling. Site specific health and safety plans (HASPs) will identify air monitoring details.

21.1 Scope

This procedure applies to Langan Engineering & Environmental Services, Inc. (Langan) work sites covered by 29 CFR 1910.120 where exposure to potentially hazardous materials may occur.

21.2 Definitions

Direct Reading Instruments (DRIs) - Instrumentation operating on flame ionization, photoionization, or infrared principles providing real time readings of ambient contaminants in air usually in parts per million.

21.3 Responsibilities

Health and Safety Coordinator (HSC) - The HSC shall ensure implementation of this procedure at Langan work sites.

21.4 Procedures

21.4.1 Introduction

Surveillance for vapors, gases, and particulates may be done by collecting air samples or using DRIs.

Instruments utilizing flame ionization detectors (FIDs), photoionization detectors

(PIDs) and other similar instruments can be used to obtain air monitoring data rapidly at a site. These may be used as survey instruments or operated as gas chromatographs. A gas chromatograph can provide both quantitative and qualitative data. Survey instruments provide a relative response based on the calibration standard.

Other air contaminant determinations or monitoring may be completed by calorimetric detector tubes or passive organic vapor monitors.

21.4.2 Air Sampling

An air sampling plan should be established at the beginning of the project. As information is gathered about the site the plan should be reevaluated and modified as necessary. The locations listed below are locations where monitoring should be considered.

- A location upwind of activities - samples should be taken upwind of the site to establish background levels.
- Support Zone - Samples should be taken in the Support Zone to ensure that the area is located in a clean area, and the area remains clean during site operations.
- Contamination Reduction Zone - Air samples may be collected in the CRZ to ensure that decontamination workers are properly protected and that the area is not contaminated.
- Exclusion Zone - The Exclusion Zone requires the most air sampling. The location of air sampling shall be based upon concentrations detected by DRIs, types of substances present, and potential for contaminants to become airborne. The information obtained is used to verify the selection of levels of personal protective equipment and respirators, the exclusion zone boundaries, and provide a continual record of air contaminants.
- A location downwind - One or more sampling stations may be located downwind from the site operations to indicate if air contaminants are leaving the site.

21.4.3 Media and Methods for Collecting Air Samples

A variety of media and methods are used to collect airborne contaminants. NIOSH's Manual of Analytical Methods and OSHA sampling methods should be consulted for proper selection of appropriate media and methods.

21.4.4 Sample Analysis

Samples are analyzed to determine specific types and quantities of substances present. A laboratory accredited by the American Industrial Hygiene Association should be used for sample analysis.

21.4.5 Personnel Monitoring

Personnel monitoring is used to determine the contaminants encountered during a specific operation. As deemed necessary by the HSC, representative samples shall be collected in the worker's breathing zone, generally within nine inches of the mouth and nose.

21.4.6 Calibration

Proper calibration is essential for accurate collection and results. At a minimum, the sampling equipment system shall be calibrated prior to and after each sampling period. More frequent calibration may be necessary. Equipment should be calibrated when newly purchases, after repair, and following suspected abuse. The air sampling pump with collection medium in place should be calibrated as a unit.

Calibration should be conducted with a standard traceable to the National Bureau of Standards.

A calibration log should be maintained with the equipment.

21.4.7 Meteorological Considerations

Meteorological information is an integral part of an air sampling program and should be collected as deemed necessary by the HSC. Data concerning wind speed and direction, temperature, barometric pressure, and humidity, may be needed for:

- Selecting air sampling locations;

- Calculating air dispersion;
- Calibrating instruments; and
- Determining population at risk or environmental exposure from airborne contaminants.

21.4.8 Action Levels

Air monitoring results are used to determine where Exclusion Zones should be established and when certain levels of personal protective equipment are required. Action level criteria are used as guidelines in making these health and safety determinations. Site specific action levels may vary from the attached action levels and are determined by the HSC.

21.5 References

NIOSH Manual of Analytical Methods
OSHA Manual of Analytical Methods
29 CFR 1910.120 "Hazardous Waste Operations and Emergency Response"

21.6 Attachments

A - Instrumentation Action Level

ATTACHMENT 1A

Instrumentation Action Levels:

Instrument	Action Level	Level of Protection or Action Required
FID*	Background (Bkgd.)	No Respirator
	> Bkgd. - < 5 ppm (TWA-5mins) (non-methane)	Air Purifying Respirator (APR); Establish an Exclusion Zone if one has not yet been established
	≥ 5 ppm - < 500 ppm (non-methane)	Air Supplied Respirator
	≥ 500 ppm (non-methane)	Evacuate

* *Flame Ionization Detector calibrated to methane. Measurement made in the breathing zone of personnel.*

PID*	Background (Bkgd.)	No Respirator
	> Bkgd. - < 5 ppm (TWA-5mins)	Air Purifying Respirator (APR); Establish an Exclusion Zone if one has not yet been established
	≥ 5 ppm - < 500 ppm	Air Supplied Respirator
	≥ 500 ppm	Evacuate

* *Photoionization Detector calibrated to benzene or its equivalent. Measurement made in the breathing zone of personnel.*

Instrumentation Action Levels (continued):

Instrument	Action Level	Level of Protection or Action Required
CGI*	< 25% of the LEL	Maintain monitoring schedule
	≥ 25% to <50% LEL	Conduct continuous monitoring of the work area
	> 50% of the LEL	Shut down machinery, evacuate personnel from work area and let vent

* *Combustible Gas Indicator*

H_2S Monitor	> 5 ppm* - <10 ppm*	Conduct continuous monitoring of the work area and establish an exclusion zone if one has not yet been established.
	≥ 10 ppm - <150 ppm (TWA)**	Air Supplied Respirator
	≥ 150 ppm*	Shut down operation, evacuate personnel from work area and let area vent.

* *Samples taken at the bore hole or excavation area.*
** *Samples taken at the breathing zone.*

Aerosol Monitor	>1.5 mg/m3	Air Purifying Respirator or implement dust control measures.
Geiger Mueller Probe	>1 milliroentgen/hr.	Evacuate the work area and contact HSC

ATTACHMENT K

HEALTH AND SAFETY PROGRAM

FOR

HAZARDOUS WASTE OPERATIONS

SECTION XXIII

HEALTH AND SAFETY PROCEDURE #16
DRILLING

Revisions	Date

Langan
Engineering and Environmental Services, Inc.

SECTION XXIII
HEALTH AND SAFETY PROCEDURE #16
DRILLING

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23.0 PURPOSE

This procedure establishes general guidelines for sites involving drilling and potential exposure to hazardous materials. 29 CFR 1910.120 requires drilling procedures be established when working on sites covered by the standard. Site specific health and safety plans (HASPs) will detail drilling decontamination procedures.

23.1 Scope

This procedure applies to Langan Engineering & Environmental Services, Inc. (Langan) drilling activities where exposure to hazardous materials may occur.

23.2 Definitions

None.

23.3 Responsibilities

Health & Safety Coordinator (HSC) - The HSC shall develop adequate site-specific procedures for inclusion in the HASP.

Health & Safety Manager (HSM) - The HSM shall oversee the site-assigned HSC's development of adequate drilling procedures to prevent contamination of individuals or contamination of the environment.

Project Manager (PM) - The Project Manager will provide sufficient information to the HSC to enable preparation of adequate procedures for inclusion in the site-specific HASP.

Site Personnel - It is the responsibility of all site personnel to follow the drilling procedures as outlined in the HASP.

23.4 Procedures

23.4.1 Introduction

Despite contamination avoidance practices and personal protective equipment, personnel working around drilling operations may become contaminated with hazardous materials or may become injured during the course of work.

23.4.2 Drilling Concerns

The items below are of concern when working with a drilling operation.

- Work around heavy equipment has potential for trauma due to contact with overhead objects, cables, etc. Minimum protection from these hazards shall include safety shoes, hard hats and safety glasses.

- Special precautions may be necessary to assure the drilling is performed in an area free of underground objects including power or gas lines (generally less than 4 feet deep). Precautionary measures include a thorough review of plans and careful siting of the rig. Surveys using metal detectors (or equivalent) may be necessary.

- Care must be taken in the positioning of drilling and or other heavy equipment. Site personnel must ensure that the equipment is stable and does not block emergency access or site evacuation routes.

- Equipment operators and field personnel should be familiar with the proper selection and operation of fire extinguishing equipment. Fully charged and inspected fire extinguishers should be immediately available at the drilling site. Contingency plans should be adopted to assure safe and timely evacuation and recruitment of outside assistance.

- All site field personnel should be alert to the potential for exposure to noise levels in excess of 90 dBA. Hearing protection should be available if work patterns will require sustained exposure (greater than 1 hour) to noise.

- NIOSH has declared that diesel exhaust fumes should be considered carcinogenic. Unnecessary exposure to diesel exhaust fumes should be avoided by positioning of heavy equipment (upwind, etc.) or the use of

respiratory protection (organic vapor cartridge with filters for dust and mist) where avoidance of exposure is impossible.

- Appropriate emergency and backup personnel should remain in immediate access range to drilling or sampling activities where practical.

- Drilling operators are to be responsible for the safety of their rigs. This includes maintaining the proper grounding on set up, support (e.g., blocks and guy wires), installation guards, inspection of wire, rope, etc.

- On finished wells, covers equipped with vent plugs should be securely installed over the open well casing.

- The drill rig operator shall practice fire prevention measures including periodic cleaning of the drill rig to remove combustible/flammable residues (oil, grease, etc.).

23.5 References

29 CFR 1910.120 "Hazardous Waste Operations and Emergency Response"

23.6 Attachments

None.

ATTACHMENT L

HEALTH AND SAFETY PROGRAM

FOR

HAZARDOUS WASTE OPERATIONS

SECTION XXIV

HEALTH AND SAFETY PROCEDURE #17
SOIL AND WELL SAMPLING

Revisions	Date

Langan
Engineering and Environmental Services, Inc.

SECTION XXIV
HEALTH AND SAFETY PROCEDURE #17
SOIL AND WELL SAMPLING

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24.0 PURPOSE

This procedure establishes general procedures posed by work activities necessary as part of proper sample collection techniques and quality assurance practices for sites. The site specific health and safety plan (HASP) will detail drilling decontamination procedures.

24.1 Scope

This procedure applies to Langan Engineering & Environmental Services, Inc. (Langan) sampling activities where exposure to hazardous materials may occur.

24.2 Definitions

None.

24.3 Responsibilities

Health & Safety Coordinator (HSC) - The HSC shall develop adequate site-specific procedures for inclusion in the HASP.

Health & Safety Manager (HSM) - The HSM shall oversee the site-assigned HSC's development of adequate sampling procedures to prevent contamination of individuals or further contamination of the environment.

Project Manager (PM) - The Project Manager will provide sufficient information to the HSC to enable the preparation of adequate procedures for inclusion in the site-specific HASP.

Site Personnel - It is the responsibility of the on site personnel to follow the sampling procedures as outlined in the HASP.

24.4 Procedures

24.4.1 Introduction

Collection of soil, waste water and/or other environmental samples at hazardous waste sites presents a variety of potential health and safety hazards, many of which are due to the use of required equipment decontamination agents to assure appropriate quality control. Health and safety concerns due to potential hazards posed by the particular work site under investigation shall be addressed by the formal HASP for that site. The following are key health and safety issues and recommended practices for field work involving sample collection at any work site. They address concerns posed by work activities necessary as part of proper sample collection techniques and quality assurance practices.

24.4.2 Sampling Concerns

The items below are of concern when conducting site sampling.

- Protection from skin contact with soil, water or waste borne chemicals requires the selection and use of garments and protective coverings that will stop the chemicals in question and will not degrade upon chemical contact. This is especially important for highly concentrated chemicals (e.g., free product, concentrated wastes and decontamination chemicals).

  A. Thin disposable latex or vinyl gloves are not designed to prevent entry of or withstand prolonged contact with many chemicals for which sampling is performed or which is used to decontaminate sampling equipment. These gloves are used primarily for quality control purposes as part of sample collection techniques.

  B. Where protection is necessary to prevent skin contact with suspect contaminants, the protective coverings should be worn under outer disposable gloves used for quality control purposes. This may require the use of large or extra large disposable gloves to accommodate inner coverings and that will not rip during donning/doffing.

- Collection of samples containing high solvent concentrations may liberate volatile organics at levels sufficient to warrant respirator use (in addition to skin protection). This is especially true where high concentrations of materials or chemical layers (floating products) are encountered. Potential emissions should be monitored and protective equipment upgraded as specified in the HASP.

- During equipment decontamination activities involving extensive use of acetone, hexane, methanol or other solvents Level C protection, including organic vapor cartridges or equivalent, may be warranted.

- In addition, eye and skin protection may be required during decontamination activities requiring the use of nitric acid. It should also be noted that improper preparation by the laboratory of acid preservatives in sampling containers may release irritating fumes unexpectedly upon addition of liquid samples.

- Transport and storage of chemicals required for decontamination procedures require appropriate safeguards to prevent contact between incompatible and/or combustible materials. Nitric Acid is an oxidizer capable of starting a fire upon contact with flammable or combustible materials.

The attached table highlights key precautions for safe work with common sample decontamination materials.

24.5 References

29 CFR 1910.120 "Hazardous Waste Operations and Emergency Response"

24.6 Attachments

A. Common Sample Decontamination Agents Health and Safety Concerns

COMMON SAMPLE DECONTAMINATION AGENTS HEALTH AND SAFETY CONCERNS

ATTACHMENT A

Chemical	P.E.L.	Safety Hazard	Acute Health Hazard	Chronic Health Hazard	Precautions
Acetone	750 ppm	Flammable	Respiratory Irritation		Well ventilated Area, Respirator (OV) & Gloves (1)
Methanol	200 ppm	Flammable	Irritation CNS Drowsiness Light Headed Dry, Cracked Skin	Vision Damage (Optic Nerve)	Well Ventilated Area, Respirator (OV) Gloves (1,2)
Hexane	50 ppm	Flammable	Irritation Light Headed Dry, Cracked Skin	Nerve Damage (Polyneuritis) Numbness Weakness in Limbs	Well Ventilated Area, Respirator (OV) Gloves (1,4)
Isopro-panol	400 ppm	Flammable	Mild Irritation Eyes, Nose Throat, Dry, Cracked Skin		Well Ventilated Area, Respirator (OV) Gloves (1,2,4)
Nitric Acid (concentrated 68% solution)	2 ppm	Oxidizer	Irritation of Eyes, Upper Respiratory Tract, Skin	Corrosive to tissue on extended contact	Goggles, Skin Covering Gloves (1,2,3,4) Eye Wash Immediately ** **Avoid contact with Combustibles or Flammables**

OV Organic Vapor Cartridge

Glove Legend

1	Silver Shield	2	Neoprene
3	Natural Rubber	4	Nitrile